

PHELPS (C.)

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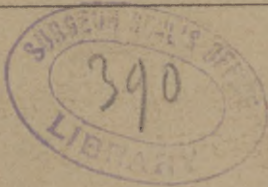
BY

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SURGEON TO BELLEVUE AND ST. VINCENT'S HOSPITALS.

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A CLINICO-PATHOLOGICAL STUDY OF  
INJURIES OF THE HEAD,  
WITH SPECIAL REFERENCE TO  
LESIONS OF THE BRAIN SUBSTANCE.\*

BY CHARLES PHELPS, M. D.,  
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Two years ago I read before this association, in the course of a general discussion upon cerebral surgery, a very brief paper upon cerebral contusion. Since that time a very considerable number of cases of serious injuries of the head, almost all of which have involved lesion of the brain substance, have come under my observation. They present so many points of interest and importance that I have ventured to ask renewed attention to an extension of the same subject. In no department of surgery are more problems yet unsolved, and in no department are the results of careful study likely to be of more absorbing interest or of greater professional value.

Attention has been largely directed to cerebral localization, and to certain surgical procedures founded upon the

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indications it has afforded. Such operations upon the brain have been conspicuously successful, and have been justly reckoned among the triumphs of modern surgery. When guided by the disclosures of physiological experiment and aided by the application of recognized aseptic laws, operations upon the brain have been devised and successfully executed which in the immediate past would have been not only impossible but incredible. It is equally true that these operations are still limited in number and application. The instances in which brain lesions can be accurately defined and located and afterward made subject of operation with reasonable prospect of success are comparatively infrequent. The lesions which are of such nature, so well defined in outline, or so situated, in view of demonstrated localization of brain function, that their diagnosis can be made with reasonable certainty, are few enough in the first instance; those which are within reach of the surgeon's knife are fewer still; and those in which the patient ultimately survives constitute but a small proportion of the originally scanty number. It is not strange, however, that operations which invade the very penetralia of the human organism should fascinate by their audacity, and that, when successful, they should dazzle the modest workers in more prosaic fields of labor. It is also possible that the ardor with which the diagnosis and relief of local lesions of the brain have been pursued, in the light of functional localization, may tend to distract attention from those general pathological conditions which are of so much greater frequency. The study of cerebral topography, moreover, has been so much more effectively prosecuted by the physiologist than by the pathologist, that perhaps the results of clinical and pathological work have been practically if not theoretically underrated. It is certainly proper at the present time to more generously supplement physiological experimentation



by both ante-mortem and post-mortem observations made upon the human subject. For this purpose, cerebral traumatism, which this series of cases illustrates, affords peculiar advantages, since death results from the establishment of lesions in a previously healthy brain, and since it presents itself with sufficient frequency for purposes of comparison.

The cases which I propose to subject to analysis are one hundred and twenty-four in number, and, with two or three exceptions, have been previously unreported. They have occurred mainly in my service in two hospitals, and in the last two years. They include all cases of injuries of the head which I have seen during the time specified, and if they are preponderatingly of one character, they are probably still representative of the whole class to which they belong. Wounds of the scalp have not been included because they are not only surgically insignificant, but have no necessary relation to the deeper-seated injuries which it is proposed to consider. In a previous paper upon a subject of an entirely different character, I found it convenient to abstract the histories of the several cases upon which it was based. I pursue the same course in the present instance in order to afford a means of verification of such conclusions and generalizations as I may establish, and at the same time to make record of a large amount of material which may be of service hereafter to students of the same class of injuries. I shall not attempt a reading of these histories, but shall leave them to appear in the archives of the association for future consultation. They are arranged in accordance with the nature and result of the primary injury.

#### FRACTURES AT THE BASE.

CASE I.—Male, aged forty-five; fell in the street; admitted to alcoholic ward; wild delirium, requiring mechanical re-

straint; hæmorrhage from left ear; wound in posterior parietal region; high temperature; coma; death in forty-eight hours.

*Necropsy.*—Fracture at the base, with complete separation of the left temporal bone into its constituent parts—squamous, petrous, and mastoid. Slight laceration of left parietal lobe at a point corresponding to seat of external injury. At a corresponding point upon opposite parietal lobe there was extensive laceration 3·5 inches  $\times$  1·5 inch in diameter.

CASE II.—Male, aged forty; said to have fallen from his truck; no superficial injury; delirium, which was considered alcoholic; refused treatment; delirium continued next day, and he committed suicide by drowning.

*Necropsy.*—Fracture at base extending from left parietal eminence to foramen magnum. Superficial laceration of right temporo-sphenoidal lobe by *contre-coup*.

These two cases have been previously reported.

CASE III.—Male, aged fifty; fell from steps to sidewalk; scalp wound in right posterior superior parietal region; hæmorrhage from right ear, and later from right nostril; coma; stertor; rigidity of all the limbs; left pupil dilated. In twelve hours complete left hemiplegia supervened, and hæmorrhage from right ear renewed. Stertor and rigidity disappeared, and left pupil became normal. Unconsciousness and incontinence of urine continued from time of admission till death from as-thenia at the end of six days.

*Necropsy.*—Fracture at base, beginning at point of injury and extending through right petrous portion and middle fossa to apex of opposite petrous. Lacerations of left frontal and right temporo-sphenoidal lobes inferiorly and laterally. Thick clot over left frontal and temporal lobes laterally, growing thinner as it extended toward base and vertex. Whole brain intensely hyperæmic

CASE IV.—Male, aged twenty-two; cause of injury unknown; compound depressed fracture external to right parietal eminence; semi-comatose, irrational, articulation indistinct; respiration continued slow and irregular for three days. The depression was found on trephination to be of the external table only. Two days after admission, complete paralysis of ex-

tensors of right hand, paresis of right arm, and right facial paralysis, involving both mouth and eyelid. All these paralyses afterward varied in degree from time to time, and the mental condition varied from rationality to noisy delirium. He was usually restless, and became unconscious for two days before death. Temperature on admission,  $101^{\circ}$ , and remained above  $100^{\circ}$  for a week. Then declined to  $99^{\circ}+$  during another week. Two days before death it rose steadily from  $103^{\circ}$  to  $109^{\circ}$ . Died in forty-five days.

*Necropsy.*—Fissure extending from point of depression into right middle fossa. Subacute arachnitis and excessive cerebral hyperæmia; surface of brain at point of fracture unchanged, but beneath it was a large cavity containing reddish semi-fluid material, and brown detritus from subcortical laceration.

CASE V.—Male, aged thirty-five; cause of injury unknown; scalp wound over occipital protuberance; patient under influence of drink; would not answer questions; grew stupid, and in three hours became unconscious; mechanical restraint necessary. Temperature soon after admission was  $102^{\circ}$ , and in ten hours became  $105^{\circ}$ , receded to  $101.8^{\circ}$ , and then rose steadily to  $106.6^{\circ}$ . He died twenty-nine hours after admission.

*Necropsy.*—Hæmatoma covered whole calvarium. No fracture of vertex, but a slight fissure existed along the posterior border of the right petrous portion of temporal bone from *contrecoup*. Thin coagulum and fluid blood covered upper surface of both cerebra (meningeal contusion). Lacerations of under surface of left frontal (large) and temporo-sphenoidal, of inner border of right frontal, and of under surface of right temporo-sphenoidal lobes. The last was as large as a hickory nut.

CASE VI.—Male, aged thirty-eight; knocked down by a blow upon the head from a club; scalp wound in right parietal region. He was stupid, and could not answer questions coherently. Left pupil slightly dilated and eyes directed slightly to the right. Next day incoherent, delirious, and had delusions and muscular tremor, pupils irregular, pulse frequent and intermittent. Temperature on admission  $103^{\circ}$ , five hours later  $102^{\circ}$ , rose to  $106.2^{\circ}$ . Died in twenty-four hours.

*Necropsy.*—Linear fracture through whole length of right



parietal, right occipital, and petrous portion of temporal bone into middle fossa. Considerable laceration of under surface of left frontal and temporo-sphenoidal lobes.

CASE VII.—Male, aged forty-five; fell upon the sidewalk, striking the back of the head. Admitted after twenty-four hours. Œdema under and about an old cicatrix behind the right ear, and underneath this an extensive comminuted fracture. Two pieces of bone were removed and one elevated, and a large, firm epidural clot extracted as far as possible. The patient was in a condition of stupor; pupils irregularly dilated; articulation difficult; muscles generally rigid; gait ataxic when he attempted to walk; sensibility diminished; and urine incontinent. His condition improved for four days after operation; temperature decreased, mental condition became clearer, and muscular rigidity lessened. There was copious serous discharge from the right ear, followed by right facial paralysis. On the fifth day temperature rose from normal, muscular rigidity again increased, and he again became stupid. The next day he became unconscious, and in an hour's time he had eighteen general convulsions, and died the following morning. His temperature did not exceed  $99.8^{\circ}$  till the fifth day. On the morning of his death it was  $105^{\circ}$ .

*Necropsy.*—Fracture at the base. The whole central portion of the occipital, from the foramen magnum upward, and posterior portion of both parietal and right temporal bones, forming an irregular circle two inches and a half to three inches in diameter, were broken into large fragments, two of which had been removed during life. The mastoid and outer part of the petrous portion of the right temporal bone could be removed by the fingers with the use of very little force. This line of fracture ran through the tympanic cavity, so that, after removal of the outer fragment, the carotid canal and aqueductus Fallopii could be seen in the section filled with coagula. A large epidural clot was situated beneath the occipital fracture, extending half an inch beyond its margin. A large subdural clot filled the right inferior occipital fossa, extending to the foramen magnum. The cavity of the posterior part of the great longitudinal sinus was occupied by a thrombus, and its walls were infiltrated



with blood. There was a large, partially decomposed thrombus in the torcular Herophili, extending through the right lateral into the petrosal sinus and internal jugular vein. The whole internal surface of the dura beneath the seat of the external hæmorrhage was lined by a firmly coagulated clot, with an inflammatory exudation around it. A portion of the surface of the right occipital lobe posteriorly was softened, showed minute hæmorrhages, and was torn away in the removal of the dura. The meshes of the pia mater over a large part of the parietal and occipital lobes posteriorly were distended with slightly turbid serum. There was a small laceration on the under surface of each frontal lobe, and a larger one, three quarters of an inch in diameter, existed in the right cerebellum at a point corresponding to the site of the thickest part of the subdural hæmorrhage.

CASE VIII.—Male, aged seventy-six; cause of injury unknown; admitted to alcoholic ward, and transferred to surgical service same day. Patient unconscious from the time he was found in the street. Stertor; muscles rigid on both sides; both pupils very strongly contracted, the left one the more so. Scalp œdematous in right parietal region. Fissure, extending from posterior and inferior part of right parietal into occipital bone, discovered by incision. There was no change in the general symptoms up to the time of death, two days and six hours after admission. The left pupil continued to be the more strongly contracted, and muscular rigidity continued to be more strongly marked on the right side. Consciousness was not regained. Temperature on admission,  $100\cdot4^{\circ}$ ; rose steadily to  $103\cdot8^{\circ}$ ; post mortem,  $102^{\circ}$ .

*Necropsy.*—Fracture at base extended to right jugular foramen, and then turned backward to foramen magnum. Slight epidural and considerable subdural hæmorrhage at point where fracture began. Slight serous effusion into pia. Thrombus in torcular Herophili, extending into right occipital sinus and through petrosal sinus into jugular vein. The whole inferior surface of the brain covered with blood. Superficial laceration along the anterior border of left temporo-sphenoidal lobe from median line outward. Large clot could be seen bulging out-

ward, behind a thin cortical layer, along the whole length of external border of left frontal lobe. Well-marked lacerations upon anterior border of both frontal lobes, and also upon their inferior surfaces along the longitudinal fissure. Optic chiasm surrounded by a clot, which extended backward as far as anterior border of the pons Varolii. Upon section along external border of left frontal lobe, a clot of great size was disclosed, which occupied almost the whole substance of the left frontal and temporo-sphenoidal lobes, from the third frontal convolution backward. This hæmorrhage had broken through into the lateral ventricles and thence into the occipital lobes, which were also filled with great pools of fluid blood.

CASE IX.—Male, aged forty; fell into the hold of a vessel; semi-conscious when found; hæmorrhage from both nostrils and from right ear; regained consciousness next day; four days later delirious and irritable; back of neck rigid; abdomen retracted; death at end of five days. Cheyne-Stokes respiration supervened. Temperature for seventy-two hours,  $99.2^{\circ}$  to  $99.8^{\circ}$ ; fourth day,  $103.2^{\circ}$ ; fifth day,  $104.8^{\circ}$ .

*Necropsy.*—Contusion over right mastoid revealed on raising the scalp. Fracture at base in three fissures; extending from this point, two (fine) across petrous portion, and a third connecting them posteriorly across occipital bone. Deep linear laceration, extending across inferior surface of right cerebellum, near outer border. Subdural hæmorrhage over whole left cerebrum, superiorly and laterally; most copious in middle lateral region. Laceration of antero-inferior border of left frontal lobe. White substance of left cerebrum much congested, and with punctate extravasations throughout its extent.

CASE X.—Female, aged eight; fell two stories; partially unconscious; left hemiplegia, and hæmorrhage from left nostril; depressed fracture over left frontal eminence. Patient became irritable, and the bone was elevated an hour later. Died within twenty-four hours.

*Necropsy.*—Coronal suture separated on the right side. A fissure extended through right parietal eminence and another through frontal bone. Base fractured across body of sphenoid into left middle fossa. Other fissures through right middle and

anterior fossæ, external to orbital plate. Epidural hæmorrhage on left side anteriorly and in temporal region. Lacerations in right frontal lobe and in right fissure of Rolando and in left temporo sphenoidal lobe.

CASE XI.—Male, aged twenty nine; fell fifteen feet into the hold of a vessel and struck on his head. Coma, stertor: left pupil markedly dilated and right pupil contracted; paraplegia, hæmorrhage from left ear and nose and under left conjunctiva, and contusion over left eye. Died in five minutes after admission.

*Necropsy*.—Epidural hæmorrhage, blood still fluid. Fracture extending downward and forward from behind left parietal eminence, across petrous portion, through middle fossa, transversely across anterior fossa, and terminating at inner extremity of lesser wing of right sphenoid. Slight cortical hæmorrhage on left side, and slight lacerations of under surface of left frontal and temporo-sphenoidal lobes.

CASE XII.—Female, aged twenty-three; jumped from fifth-story window. Contusions of left hip and shoulder and over right parietal eminence; slight hæmorrhage from nose and left ear; temperature, 99·4°; incontinence of urine and feces; right hemiplegia. Death in two days.

*Necropsy*.—Fracture extending from right parietal eminence to foramen magnum, of right petrous portion entire length, and of left petrous for two inches; laceration of left parietal lobe beneath parietal eminence.

CASE XIII.—Male, aged forty-six; fell five stories. Coma, stertor, pupils normal; pulse and respiration normal. Death in five days.

*Necropsy*.—Contusion over right parietal eminence; fracture extending from this point downward and forward, anterior to petrous portion, and through sella turcica; subarachnoid hæmorrhage over both hemispheres; laceration of under surface of left temporo-sphenoidal lobe.

CASE XIV.—Male, aged fifty; knocked down by a blow in the face and fell upon the back of his head. Patient became unconscious, but shortly afterward walked to the hospital; contusion over right parietal eminence; dazed; no other symp-

toms; walked home; had severe pain in the head for three hours after the injury, then became gradually unconscious till four hours later, when coma was complete and death occurred at the end of another hour.

*Necropsy*.—Wound of lip and contusion of forehead: fissure of external table, very fine, beginning in right inferior occipital fossa and running across right petrous portion; slight epidural hæmorrhage about the middle of the fracture; upon left side, large subdural extravasation upon lateral border of parietal and frontal lobes, extending upward and also downward into middle fossa; also some extravasation into pia and several slight contusions of brain substance; skull thin, and angles and processes upon its inner surface unusually sharp and prominent.

CASE XV.—Male, aged forty; cause of injury unknown. Coma; respiration slow and full; right pupil dilated, left contracted; reflexes lost; had been seen to move the left side; pulse became slower and breathing more labored. Died in nine hours and a half.

*Necropsy*.—Contusion in left parietal region: fracture from this point extending by two fissures into anterior and middle fossæ; large epidural hæmorrhage from rupture of left middle meningeal artery; slight laceration of left parietal lobe at point where fracture began, and another upon lateral border of right temporo-sphenoidal lobe.

CASE XVI.—Male, aged fifty-five; fell upon the street. Unconscious; respiration labored; left pupil slightly dilated; slight hæmorrhage from left ear; slight rigidity of left side. He was still stupid upon admission, but could give his name. Temperature, 99°. Dilatation of left pupil and rigidity of left side increased, and afterward there was complete paralysis of left lower extremity, while left arm remained slightly rigid; left hemiplegia was finally complete. He died in twenty-one hours. Temperature, 101.2°.

*Necropsy*.—Contusion of scalp over left occipito-parietal suture; skull thin; stellate fracture, originating about the center of left parietal bone; fissures extending upward, across base of occipital and along the upper border of petrous portion of temporal bone into the middle fossa; subdural hæmorrhage



covered right hemisphere; under and lateral surfaces of right temporo-sphenoidal lobe extensively lacerated; under surface of both frontal lobes lacerated along the median fissure; these lacerations were recent; upon the under surface of the left temporo-sphenoidal lobe there was a deep laceration, irregular in outline, but about an inch in its several diameters; there were also small and deep lacerations upon its anterior border and upon the under surface of the left frontal lobe. All these lacerations upon the left side extended through the cortex, contained no recent clot, but were covered with a grayish-yellow viscid substance, and were bounded by a considerable area of yellow softening. They evidently antedated the final and fatal injury. Section of the brain disclosed marked hyperæmia.

CASE XVII.—Male, aged fifty; cause of injury unknown. Unconscious; pulse, 66; respiration full and slow; right pupil dilated, the left contracted, neither one responding to light; he had been seen to move the left side of the body; stertor supervened and death occurred in eleven hours.

*Necropsy.*—Contusion of left parietal region disclosed by incision; two fissures originated from this point, one extending into the anterior and the other into the posterior fossa; large epidural clot from rupture of left middle meningeal artery; general contusion; hyperæmia.

CASE XVIII.—Male, aged thirteen; fell two stories. Hæmorrhage from right ear; unconscious; irritable when disturbed; consciousness regained in thirty minutes; pulse 78, intermittent; temperature, 98°; depressed fractures below right temporal ridge; elevated next day; three fissures, one backward, one forward, and one downward; dura incised; only subarachnoid hæmorrhage; temperature, 101·8°. Next day patient irritable and somnolent; urine incontinent; temperature slightly increased (102°). On second day after operation he was delirious, and temperature rose steadily till evening, when it was 105·4°. On the third day the skin was hot and he was very restless and sensitive to external impressions; his pupils were moderately dilated and reacted slowly. From this time he was in deep coma; temperature varied from 104°+ in the morning

to  $105^{\circ}$  + in the evening till death on the evening of the seventh day, when it was  $106^{\circ}5$ .

*Necropsy*.—Skull thin. No pus in the wound or in the small brain cavity which had been disclosed by the ante-mortem operation when the depressed bone was elevated. Subdural hæmorrhage in the opposite (left) occipito-parietal region. An effusion of thick green pus beneath the arachnoid covered the lateral and superior surfaces of the right occipital and parietal lobes, but did not extend forward to within an inch of the cranial opening left by the ante-mortem operation. A subdural effusion of similar thick green pus was coextensive with the whole right inferior occipital fossa. There was a deep laceration, an inch in diameter, upon the lateral border of the left temporo-sphenoidal lobe, which involved the subcortical tissue. At a point directly beneath the opening left by the removal of the depressed bone there was a cavity in the brain substance as large as a hickory nut which opened by its whole extent upon the cerebral surface. (As this surface was intact at time of operation, the cavity must be ascribed to a direct contusion, subcortical, not involving superficial laceration, and to a subsequent giving way of the cerebral cortex under the influence of arterial pulsation, and in the absence of normal repressive force exerted by the skull and dura.) The whole brain substance and meningeal vessels were intensely hyperæmic, and there were numerous minute extravasations from general contusion. There was no meningeal or ventricular serous effusion. A fissure extended from the central point of fracture through the petrous portion of the temporal and inferior occipital fossa to the foramen magnum.

CASE XIX.—Male, aged nineteen; fell three stories through a hatchway; unconscious; irritable when disturbed; pulse, 80; temperature,  $100^{\circ}$ ; profuse hæmorrhage from left ear, which continued twenty-four hours, and was then followed by serous discharge. At the end of twenty-four hours patient was still unconscious, pupils were largely dilated and movable, and he had general convulsive movements, most marked in the right leg. During the second day coma was more profound and general convulsive movements ceased, but he had one prolonged

general convulsion, which was repeated on the third day, the movements being most violent on the left side. The left pupil continued from the first day to be more contracted than the right. Died in three days and six hours. Temperature continued to rise from time of admission, and reached  $107.2^{\circ}$ .

*Necropsy.*—Large hematoma in substance of left temporal muscle. Fracture extended from left squamous portion of temporal bone into middle fossa, and by a wide fissure along the anterior border of the petrous portion to the sella turcica. Large epidural and subdural clots in left middle fossa. Right cerebrum covered by a thin subdural coagulum. In the left middle fossa diffuent brain substance clung to the dura as it was removed. Large and deep laceration of the lateral border of the left temporo-sphenoidal lobe and of the lateral border and contiguous inferior surface of the right temporo-sphenoidal lobe. Small and deep laceration at junction of right parietal and occipital lobes. All these lacerations extended into the subcortical tissue.

CASE XX.—Male, aged sixty-two; cause of injury unknown; found unconscious in an ice wagon with his head lying on a cake of ice. Contusion of left parietal region, and both eyes much ecchymosed. Subconjunctival hemorrhage at outer part of left eye. Muttered incoherently when disturbed. Slight temporary rigidity of right arm. Restless and irritable all day, and roused sufficiently in the evening to give a name and address, both of which proved to be incorrect. Condition underwent little change till death—at the end of seven days and seven hours. Temperature high on admission— $101^{\circ}$ ; in forty-eight hours,  $104.6^{\circ}$  to  $104.8^{\circ}$ ; seventy-eight hours later it receded to  $101.2^{\circ}$ ; in forty eight hours more it varied from  $101^{\circ}$  to  $102^{\circ}+$ , and then rose steadily to  $107^{\circ}+$  at the time of death.

*Necropsy.*—Skull thin; fracture of left anterior and middle fossae, apparently beginning with a comminution of orbital plate of left frontal bone about its center. At this point two or three small fragments were displaced upward with fine fissures running off in different directions. One fissure ran outward and upward into left squamous portion of temporal bone; another ran backward from the crista galli through the bodies of the

ethmoid and sphenoid, through the optic foramen and along the anterior border of the petrous portion; and the third ran through the right optic foramen into the squamous portion of the right temporal. The optic nerves were uninjured. There was a little blood extravasated over right occipital and lower part of right parietal lobes. The left frontal lobe was completely excavated by a laceration, which was bounded everywhere by a thin layer of unaltered cortex, except inferiorly, near the anterior border, where it was covered in only by the meninges. It was separated from the ventricle by a thin septum of brain substance. This cavity contained commingled blood, clot, and brain detritus. There was also a laceration of the anterior two thirds of the external lateral border of the right cerebellum, and an extravasation the size of a robin-shot existed in the center of the right corpus striatum. There was no clot anywhere at the base of the brain and no further lesions.

CASE XXI.—Male, aged twenty-seven; fell seventeen feet into the hold of a vessel, striking his face and stomach. Thirty minutes later an officer found him lying upon the dock unconscious and bleeding from the mouth and nose. In the interval which had elapsed he was said to have been excited and abusive. He was seen upon the dock and twice afterward during the night at the station-house by ambulance surgeons, who refused to take him to a hospital, because, in their opinion, he was simply drunk and in no want of surgical treatment. The next morning he was taken to court by two policemen. He was then conscious, and, in their inexpert opinion, rational. He was unable to stand or walk, and was carried between them on their arms into a street-car and into court. He was duly sentenced for intoxication, but by an inspiration of somebody he was halted on his way to the Island and placed in the alcoholic ward at Bellevue. A little later he was transferred to a surgical ward. At that time he was weak, his pulse slow, and respiration labored. There was much ecchymosis of the eyes, and the lids could be separated only with great difficulty. There was subconjunctival hemorrhage of both eyes, and the arms were rigid, more especially the right. Pupils normal. The patient soon grew restless, and had muttering delirium, inconti-



nence of urine, and Cheyne-Stokes respiration. Temperature,  $104.8^{\circ}$ . Depressed fracture easily felt in right frontal bone. The same afternoon he was trephined, and the fracture found to be stellate, with a depression an inch by half an inch in diameter. The inner table was driven through the dura. Pulse and respiration temporarily improved, but he grew weaker, and died eight hours after admission to the ward. Temperature,  $106^{\circ}$ .

*Necropsy*.—I am indebted to the report of Dr. W. S. Jenkins, late of the coroner's office. There was a linear fracture in the temporal bone three inches long, extending upward and backward from the anterior margin. There was a stellate fracture in the frontal bone to the right of the median line and an inch above the superciliary ridge. On the inner surface of the skull the fracture extended across both orbital plates, through the ethmoid and body of the sphenoid bone, and on both sides through the anterior fossa and through the left middle fossa nearly to the petrous portion of the temporal bone. The nasal bones were also fractured. These fractures were nearly all comminuted. There was no considerable hæmorrhage in the cranial cavity. The upper surfaces of both hemispheres were lacerated, especially at seat of fracture.

CASE XXII.—Male, aged thirty-nine; fell from mizzen-top to deck, and struck upon right temporal region; admitted half an hour later; unconscious, and bleeding from right ear; stertorous breathing; pulse full and bounding; lacerated wound in right parietal region. He had pulmonary œdema, for which he had already been bled from the arm by the ship's surgeon. Died in two hours.

*Necropsy*.—Hæmatoma over whole right side of the head. Multiple fissures of the base (six in number), involving both sides and all the fossæ. The primary fissure, of five which were connected, began as a wide fissure behind and a little to the left of the foramen magnum, and narrowed to a hair's breadth as it ran forward to the right superciliary ridge. A sixth and entirely independent fissure ran backward from the crista galli on the left side through the optic foramen to the sella turcica. There were slight lacerations of under surface of both frontal and right temporo-sphenoidal lobes, which occa-

sioned slight subdural hæmorrhage. Upon the upper and lateral surfaces of the hemispheres, especially the left, and at the base, an epidural hæmorrhage of larger size existed in the inferior occipital fossæ, and pressed upon the pons and medulla.

CASE XXIII.—Male, aged forty; found at foot of cellar stairs, unconscious and restless, with a large lacerated scalp wound, which had bled freely, and several wounds of the face. Admitted to the alcoholic ward on the diagnosis of ambulance surgeon of another hospital, still unconscious. The scalp wound was in the parieto-occipital region, to right of median line, and the most extensive face wound was over the right malar bone. As he did not "clear up," he was transferred to a surgical ward four days afterward. He was then nearly comatose, quiet unless disturbed, his pupils normal, and respiration slow and regular. Temperature,  $102.2^{\circ}$ ; pulse, 96. Temperature next day was  $104.6^{\circ}$ ,  $103.6^{\circ}$ , and  $106^{\circ}$ ; and on the morning after it was  $105^{\circ}$  and  $107^{\circ}$ , when he died without further symptoms five days and a half after reception of injury.

*Necropsy.*—Fracture at base, through petrous portion of left temporal bone, extending to foramen magnum. Laceration of left temporal and frontal lobes, with cortical hæmorrhage.

CASE XXIV.—Female, aged thirty-eight; habitual criminal; jumped from the third tier of the Tombs Prison to the flagging below, thirty feet or more; punctured wound in left occipito-parietal region; unconscious; hæmorrhage from left ear; pupils moderately dilated, more especially the left; and vomiting persistent. Temperature,  $98.9^{\circ}$ . The next morning the patient was conscious, rational, and the hæmorrhage had nearly ceased. In the evening she was slightly delirious, and the following day required mechanical restraint till quieted by sedatives. Both pupils became widely dilated, the left still continuing more dilated than the right, and they were only slightly responsive to strong artificial light. This ocular condition continued till her death. The abdomen was painful and swollen. Her mind remained clear, but apathetic, till the sixth day, when she fell into a stupor. On the same day all the extremities became paretic and partially anæsthetic. Up to this time the muscular power had been normal. The paresis and anæsthesia were most marked

on the right side. The pulse was rapid, quick, and feeble. A day later the left foot and right hand were less paretic, and her mind was clear, but the senses blunted. She answered questions slowly and after an interval, and complained of pain in the head. On the eighth day she was restless and irritable, and had some right facial paralysis, while power in the left foot and right hand was still further improved. The ninth day she was delirious and unconscious. On the eleventh day she no longer moved or spoke, and paid no attention to an explorative incision. On the fifteenth day she died from asthenia. The temperature remained below  $100^{\circ}$  till the close of the fourth day, when it rose to  $103^{\circ}$ . After that it varied from  $100^{\circ}$  to  $102^{\circ}+$ ; usually was  $101^{\circ}+$  till the twelfth day, when it rose to  $104^{\circ}$ , and was from  $103^{\circ}$  to  $104.5^{\circ}$  till she died.

*Necropsy.*—Head large and unsymmetrical, and skull thick. No lesion of the scalp or of the bone before removing the calvarium. The occiput was disproportionately large, and the right occipital fossæ were much larger than the left. The left middle and anterior fossæ were rather larger than the right. A fissure began at a point in the squamous portion of the left temporal bone, beneath the external wound, and, passing through the anterior surface of the petrous portion, terminated in the optic foramen. This fissure was not open, but the fragments were quite movable. There was no epidural hæmorrhage, but pressure was made upon the facial nerve by interosseous hæmorrhage as a result of the fracture. There was no meningitis, and scarcely the usual amount of serum in the meshes of the pia. There were slight lacerations upon the under surface of the right temporo-sphenoidal lobe, and one somewhat larger upon its external border, from which a moderate amount of blood had spread upward over the occipital lobe, barely reaching the parietal. Upon section, the cerebral vessels were found to be distended with blood, which flowed from the puncta vasculosa. The veins could be seen in congeries and filled with coagula. The brain substance was softened and cedematous, so that the serum followed the knife. The ventricles were distended with serum. Subsequent microscopic examination of the brain tissue in the recent state disclosed no inflammatory

changes. There was a considerable extravasation of blood behind the peritoneum on the right side, but no injury of the viscera. There were no serous effusions in the cavities of the body, and no chronic visceral lesions.

CASE XXV.—Male, aged thirty-seven. Cause of injury unknown; scalp wound in right posterior temporal region; hæmorrhage from right ear; mental condition stupid, but consciousness retained; incontinence of urine and feces. The patient had been drinking to excess. On the next day he had active delirium, with tremulous muscles and delusions and intervals of semi-unconsciousness. On the sixth day there was general muscular rigidity, stertor, and muttering delirium. The right pupil was slightly contracted, with slight serous discharge from right ear and slight right facial paralysis. Unconsciousness followed. On the eighth day there were two slight convulsions involving both arms, the face, and eyes. The face was drawn to the right and the eyes turned upward. Paralysis of right arm and face succeeded, and a little later the surface temperature of the left side was found to be  $102^{\circ}$ , while that of the right side was normal. Rectal temperature,  $105.6^{\circ}$ , which soon declined to  $104.8^{\circ}$ . Death two hours later. Post-mortem temperature,  $106^{\circ}$ . The temperature varied from  $100^{\circ}$  to  $102^{\circ}$  till fourth day, then from  $103^{\circ}$  to  $104^{\circ}$  to last day, when it was as noted above.

*Necropsy*.—Fissure across petrous portion of right temporal bone. Large subarachnoid serous effusion. Thin cortical layer of blood covering whole of parietal and occipital lobes on both sides of the brain. Meningeal vessels congested. Brain structure everywhere œdematous. Minute vessels filled with coagula. Fluid blood in anterior cornu of left lateral ventricle. Laceration of upper and outer surface of right frontal lobe, and upon upper and outer surface and posterior border of left occipital lobe. A third laceration existed at the base of the brain upon either side of the median fissure of the cerebellum. Neither of these lacerations was larger than a walnut, and neither involved a rupture of the meninges, though they all reached the surface of the brain.

CASE XXVI.—Male, aged twenty-three, thrown from a



wagon. The ambulance surgeon found him dizzy and feeling ill. He had no other symptoms except a scalp wound in right temporal region. After admission to hospital he was entirely conscious and dictated a letter. There was hæmorrhage from right ear and nostril. Temperature,  $100^{\circ}$ . No other symptoms. Soon afterward he vomited blood copiously and became unconscious with stertor, and died in four hours from time of admission.

*Necropsy.*—Depressed fracture of right frontal bone an inch from median line and just anterior to coronal suture, triangular in form with apex extending to superciliary ridge. One fissure, originating in this depression, ran through right orbital plate, and greater and lesser wings of sphenoid, into middle fossa; another one ran through squamous into petrous portion of temporal bone, terminating upon its anterior surface. There was an epidural clot extending over lateral aspect of right frontal lobe into the middle fossa. This portion of the frontal lobe was much flattened and compressed. There was no subdural hæmorrhage and no superficial laceration of the brain. There was a small effusion of blood in the meshes of the pia on either side of the medulla, behind the pons, parallel to the anterior columns. The whole brain was hyperæmic with a multitude of punctate extravasations, and the minute vessels were filled with coagula. Upon section, a number of extravasations were found in the substance of the pons, mainly in the transverse fibers, but some in the longitudinal fibers of the crura. The smaller ones were of the size of a robin-shot. The largest one was half an inch long by a quarter of an inch wide, and was just below the surface on the right external border of its inferior surface.

CASE XXVII. —Male, aged thirty; cause of injury unknown; unconscious; coma continued till death; hæmatoma of scalp at vertex; ecchymosis at base, right side; slight hæmorrhage from right nostril; stertor; pulse, 130, irregular and weak; temperature,  $94^{\circ}$ ; rose to  $102^{\circ}$  some hours later; both eyes protruded and both pupils were dilated, left pupil most markedly so; some rigidity of right side; died same day in eight to ten hours after admission into the hospital.

*Necropsy*.—Fracture through petrous portion of right temporal into the occipital bone and into middle fossa. No fracture of vertex. Epidural clot in right inferior occipital fossa. Thin subdural clot over both frontal lobes, especially over left, extending nearly to fissure of Rolando. Small laceration of left frontal lobe on its under surface near anterior border.

CASE XXVIII.—Female, aged forty-five, fell ten feet upon her head: scalp wound in right parietal region: temperature,  $98.8^{\circ}$ . Twenty minutes after admission left lower extremity became paretic, patellar reflexes lost. Three days later temperature suddenly rose from  $99^{\circ}+$  to  $102^{\circ}$ . Next day patient became delirious. Evening temperature,  $105.2^{\circ}$ ; following morning,  $106^{\circ}$ . Death five days after reception of the injury.

*Necropsy*.—Fracture beginning in squamous portion of right temporal bone, extended through both anterior fossae, involving greater wing of right sphenoid and both orbital plates. Subdural clot, the size of a pigeon's egg, occupied the left middle fossa. Laceration of inferior surface of left temporo-sphenoidal lobe.

CASE XXIX.—Female, aged sixty-six; found unconscious at foot of cellar stairs; supposed to have been thrown down. Scalp wound in left inferior temporal region: left malar bone fractured and left side of face much confused; coma, stertor, and frothing at the mouth; moist bronchial râles; right pupil dilated, left pupil invisible from ecchymosis; right upper extremity anæsthetic and soon became paralyzed; temperature,  $101.6^{\circ}$ . Three hours later the patient was apparently moribund. On the following day she was conscious and rational and the paralysis and anæsthesia had disappeared; the pupils were normal; urine incontinent; temperature,  $99^{\circ}+$ . For a week's time her condition remained practically unchanged, except that her temperature gradually rose to  $103^{\circ}$  and in the last three days gradually fell to  $100^{\circ}$ , and that the subconjunctival hemorrhage increased. Her mental condition was apathetic, and she could be rarely induced to make a monosyllabic answer to a question asked. On the eighth day she suddenly became unconscious. Her temperature rose to  $104.8^{\circ}$  and within two hours fell to  $102.8^{\circ}$ . She became weaker and died during the ninth day, her tem-

perature having again risen to  $106^{\circ}$ . Ten minutes post mortem it was  $105.2^{\circ}$ .

*Necropsy*.—An open fissure extended through both tables of the bone from a little above and to the left of the external occipital tubercle to the left foramen lacrum posterius. There was moderate subarachnoid serous effusion. There was an apparent laceration on the median aspect of the left frontal lobe, the real character of which only became obvious upon further examination. The interior of both frontal lobes was disorganized and destroyed, having been broken down by subcortical laceration. On the left side the clot was very solid, and the external layers of fibrin on its inferior aspect were partially decolorized. It had broken through into the anterior part of the lateral ventricle and also through the cortex on the median surface, involving for a space of half an inch the motor arm area and the sensorial center below it in the gyrus fornicatus. It was this which at first sight seemed to be an independent lesion. The clot in the right frontal lobe, which was of equal size, had nowhere broken through the cortex or into the lateral ventricle. There was no cortical hæmorrhage, although there was a deep laceration on the posterior border of the left cerebellum. The interior of the brain generally was softened and reddened in patches.

CASE XXX.—Female, aged fifty; no history; admitted as case of apoplexy. Small lacerated scalp wound in left posterior parietal region; slight hæmorrhage from both nostrils; patient unconscious; movements sluggish; left pupil dilated, right contracted; incontinence of urine and feces; face flushed; visible pulsations of carotids; fine linear fracture running toward the base discovered by incision; temperature,  $101^{\circ}$ ; at night,  $101.8^{\circ}$ ; next day,  $101.2^{\circ}$  to  $101^{\circ}$ ; then rose steadily to  $106.8^{\circ}$  on the next day, when death ensued, three days and a half after admission, without consciousness having at any time been regained. Post-mortem temperature,  $109^{\circ}$ . On the last day of life sensitiveness of the corneæ was markedly diminished and sensation was evidently blunted all over the body.

*Necropsy*.—A fissure extended from left of occipital protuberance through posterior fossa and petrous bone to foramen ovale,

There was a large, firm subdural clot, three fluidounces by measurement, in the anterior fossa, and a slight subdural hæmorrhage into right posterior fossa around the foramen magnum. A deep laceration extending below the cortex, on the under surface of the left cerebellum, made an excavation three quarters of an inch broad from the posterior nearly to the anterior border. Another extensive laceration deeply excavated the inferior portion of the right frontal and extended into the external border of the right temporo-sphenoidal lobe. Hæmorrhage from the latter laceration reached the vertex anteriorly and filled the fissure of Sylvius. Another laceration existed in the middle portion of the gyrus fornicatus, filled with brain detritus and coagulum, and extended through the cortex. This was oval in form and half an inch in diameter. There was some general contusion of both hemispheres, most marked in posterior portions.

CASE XXXI.—Male, aged forty-five; thrown from a horse and struck upon his head. He was temporarily unconscious, but on the arrival of the ambulance was able to stand, and said he felt very well. He again became unconscious on his way to the hospital. His pupils were contracted and his pulse barely perceptible. He suddenly became cyanotic and died twenty-five minutes later.

*Necropsy.*—Hæmatoma of scalp in left occipital region; blood fluid; stellate fracture of calvarium with center in left upper occipital region, and with fissures extending downward into foramen magnum, forward into middle fossa, and upward and laterally; epidural clot in occipital region; subdural hæmorrhage in inferior occipital fossa compressing the medulla; extensive subarachnoid hæmorrhage over temporo-sphenoidal and frontal lobes on both sides, with laceration of inferior surface of right frontal and temporo-sphenoidal lobes, and in slighter degree of same region on the left side.

CASE XXXII.—Male, aged thirty-four; struck by a brick falling from the fourth story. Compound, comminuted, depressed fracture of the right parietal bone extending into the base; hæmorrhage from right ear; patient conscious and without general symptoms; temperature,  $100\cdot4^{\circ}$ , and became normal;



depressed bone elevated; no injury of dura. After twenty-three days subcortical abscess of brain developed, with left hemiplegia and anaesthesia. Dura incised and abscess evacuated. Died sixteen hours later. Temperature,  $108^{\circ}$ .

*Necropsy*.—Fissure through whole length of anterior surface of right petrous portion of temporal bone; no superficial cerebral laceration; subcortical abscess cavity of small size, which had been evacuated ante mortem through the angular gyrus. This case is fully reported in the *New York Medical Journal*, March 29, 1890.

CASE XXXIII.—Male, aged thirty-three; cause of injury unknown. Consciousness lost and never regained; scalp wound in left posterior parietal region; hæmorrhage from left ear; both pupils dilated, but the right contracted later; pulse, 60; muscles relaxed and later became rigid. Death in twelve hours. Temperature on admission,  $99.6^{\circ}$ ; later,  $98.6^{\circ}$  to  $100.4^{\circ}$ ; one hour post mortem,  $101.2^{\circ}$ .

*Necropsy*.—Semicircular fracture of squamous portion of left temporal bone, with fissure extending into anterior surface of petrous portion; deep, well-defined laceration, laterally and posteriorly, of left temporo-sphenoidal lobe, from which a thick clot extended over the occipital region; brain in all its parts excessively hyperæmic; on section, the surface was repeatedly bathed in blood as it was each time wiped away; no punctate extravasation or coagula in minute vessels.

CASE XXXIV.—Male, aged forty; said to have fallen down one flight of stairs. Scalp wound in right occipito-parietal region; hæmorrhage from the nose and later occurrence of hæmatemesis; unconsciousness; stertor; pulse, 96 and full; respiration, 18; temperature,  $100^{\circ}$ ; pupils normal till just before death, when they dilated; restlessness; incontinence of urine; temperature rose gradually to  $102.6^{\circ}$  one hour ante mortem. Died in fourteen hours.

*Necropsy*.—Linear fracture in right parietal bone and extending through middle fossa and greater wing of sphenoid; small epidural clot and larger subdural clot beneath the site of fracture; dura ruptured; cortical laceration an inch and a quarter by three quarters of an inch in anterior and inferior part of

right parietal lobe; another laceration involved anterior half of middle temporal convolution on the same side. The whole brain very hyperæmic, most markedly so on left side posteriorly. In almost the exact center of the left cerebellum there was a laceration about the size of a pea filled with fluid blood.

CASE XXXV.—Male, aged forty; fell six stories. Abrasion about left eye; unconscious; pulse and respiration too rapid to be counted; temperature,  $101^{\circ}$ ; both pupils strongly contracted; rigidity of both lower and the right upper extremities; temperature in articulo mortis,  $100.4^{\circ}$ ; two hours post mortem,  $99^{\circ}+$  and pupils dilated.

*Necropsy*.—No superficial injury upon any part of the body except the abrasion noted. An extravasation of blood existed below the scalp, covering the whole left parietal region. Separation of coronal suture, left side, from about its middle point, extending outward and terminating in a fissure which, in the middle fossa, divided into two lines, one lost in the greater wing of the sphenoid, the other at the petro-mastoid junction. No epidural or subdural hæmorrhages. Cortical hæmorrhages from meningeal contusion—one covering left frontal and parietal lobes superiorly and laterally, another covering right parietal and occipital lobes on either side of their junction. No laceration on the surface of the brain, or in any part, except one three eighths by one fourth of an inch in the left corpus striatum, subcortical, and at junction of middle and posterior thirds. Excessive general hyperæmia.

CASE XXXVI.—Male, aged sixty-five; fell into the hold of a vessel; hæmorrhage from the ears and into subconjunctival tissue; conscious for twenty-four hours; both pupils dilated; temperature high; died in forty eight hours.

CASE XXXVII.—Male, aged sixty; knocked down by a truck; scalp wound in right posterior occipital region. A linear fracture running backward and downward was discovered by incision. Patient unconscious and restless. Pupils contracted; pulse, 66; very slight movements of right side of body; no facial paralysis; spoke only in monosyllables. In a short time right hemiplegia became complete, pulse weaker, temperature lower, and there was a slight general convulsion

lasting about ten seconds. Four hours later, coma was profound, pupils small and irresponsive, pulse and respiration very irregular, and restlessness ceased. The patient was trephined over left motor area. The fissure was found to extend downward behind the mastoid. Epidural hæmorrhage disclosed, and, after incision of dura, subdural hæmorrhage. He died three hours later, and eleven hours after reception of injury.

CASE XXXVIII. —Male, aged forty; cause of injury unknown; contusions behind both ears; free hæmorrhage from right ear, and during the night from both ears and mouth; pupils contracted; pulse full and slow; breathing labored; temperature,  $99.2^{\circ}$ ; became  $105^{\circ}$ . He did not regain consciousness, and died six hours after admission.

CASE XXXIX. —Male, aged twenty; fell thirteen feet; large hæmatoma in left posterior parietal region; unconscious; oozing from left ear and nose; pupils contracted, and eyes turned persistently to the right; mouth drawn slightly to the right; breathing irregular; vomiting free; extremities cold and muscles relaxed; urine incontinent; temperature,  $99.5^{\circ}$ . Soon after admission hæmorrhage from nose ceased, but continued from the ear. Patient could be roused partially but with difficulty, became restless, and moved his right side rather less freely than the left. Temperature,  $101^{\circ}$ . Two hours after admission breathing became stertorous, and tonic spasms, beginning in the right arm, became general. Two attacks of opisthotonos followed, and ceased after thirty minutes. Left pupil became the larger, while the right eye still turned to the right on exposure. Temperature,  $105.2^{\circ}$ ; pulse, 96; respiration, 32, and of the Cheyne-Stokes variety. An hour later, coma was profound, with slow and stertorous respiration. Temperature,  $106.6^{\circ}$ . Respiration became insufficient, four to the minute, and face cyanotic. Death occurred in four hours. Pupils post mortem were widely dilated.

CASE XL. —Male, aged thirty; fell three stories to the pavement; four ribs fractured on the right side; contusion over right eye, and slight right subconjunctival hæmorrhage; unconscious; skin cold and moist; pulse, 120; temperature,  $100^{\circ}$ . Pulse became weaker and respiration more labored, and death

ensued in five hours and a half after reception of injury. No pulmonary symptoms.

CASE XLI.—Male, aged forty; cause of injury unknown; extensive contusion over right parietal region: hæmorrhage from right ear and nose; unconscious; stertor; died in four hours and a half.

CASE XLII.—Female, aged forty-seven; fell on the street in a convulsion during a debauch; had other convulsions before admission; left side of head and eyelid much contused; mental condition stupid; pupils normal; breathing stertorous; pulse, 108; convulsions continued during the day and night; no interval of consciousness. During the morning a severe hæmorrhage occurred from the mouth without previous warning. In the afternoon pulse and respiration became frequent. The blood which came from the mouth was bright in color, non-aerated, and said to be more than eight ounces in amount. The next day the convulsions were diminished in frequency and were general, but more severe in the right arm. No initial symptom noted. Both arms were rigid and head constantly turned to the right. There were in all twenty-three convulsions. Death occurred in thirty-eight hours. Temperature, one hour after admission,  $102.4^{\circ}$ ; morning of next day,  $105.6^{\circ}$ ; later,  $107.4^{\circ}$ ,  $106.2^{\circ}$ ,  $107.8^{\circ}$ —the last, one hour before death.

CASE XLIII.—Male, aged seventeen; fell one story; large hæmatoma on left frontal region: unconscious till death: hæmorrhage from nose, mouth, and left ear, and under conjunctiva of both eyes; pupils equally dilated; slight convulsive movements of right side soon terminating in right hemiplegia, with rigidity of left side; death from pulmonary œdema occurred in five hours; temperature, one hour before death, was  $105.4^{\circ}$ .

CASE XLIV.—Male, aged thirty-seven; jumped from a fourth-story window to the street while drunk; lacerated scalp wound in left posterior parietal region, and fissure running from it into posterior fossa; both pupils widely dilated; patient loud and abusive in language; slight left facial paralysis; incontinence of urine; pulse, 118, soon becoming irregular and almost imperceptible. The patient became quiet, and a little later comatose. Temperature,  $97.6^{\circ}$  by rectum. Three hours after ad-



mission he had three clonic spasms of right arm at varying points. Died in six hours after admission while under ether, given for reduction of a dislocated hip.

CASE XLV.—Male, aged thirty; struck by a falling ladder; hæmorrhage from mouth and nose, and blood and brain matter exuded from the right ear; both eyes protruded, the right eye the more so; both pupils contracted and irresponsive to light; right facial paralysis; respiration stridulous. Right pupil soon began to dilate slowly. Temperature,  $100^{\circ}$ ; pulse, 93. Patient remained unconscious till death, two hours after injury.

CASE XLVI.—Female, aged thirty-five; fell down stairs; admitted next day, still unconscious; ecchymosis in left posterior parietal region; hæmorrhage from left ear; left eye protruded; left pupil dilated. Temperature,  $101^{\circ}$ ; pulse slow. Vomiting profuse. Next day paresis of whole right side; urine incontinent; some pulmonary œdema. On the third day rigidity of the muscles of the back of the neck. Hæmorrhage from the ear continued a week, lessening in amount and becoming serous in character. Patient continued unconscious till death, at the end of ten days, from asthenia. Temperature ranged from  $100^{\circ}$  to  $102^{\circ}$  till the morning of the eighth day, when it suddenly rose from  $101^{\circ}$  to  $103^{\circ}$ . From this time it rose, with morning depressions, steadily to  $107.4^{\circ}$  on the day of her death.

CASE XLVII.—Male, aged thirty-five; cause of injury unknown; found unconscious; small hæmatoma on left temple; hæmorrhage profuse from both ears; evidence of previous hæmorrhage from both nostrils; pulse scarcely perceptible; stertor; pupils both equally dilated; complete relaxation of limbs, and no response to peripheral irritation. Left facial paralysis was developed two hours before death, which occurred in six hours without restoration of consciousness. Temperature on admission was  $98.6^{\circ}$ , rose to  $99^{\circ}+$ ; pulse, 64 to 128; respiration, 24.

CASE XLVIII.—Male, aged twenty-four; fell down stairs; wound over right eye; hæmorrhage from right nostril; coma; stertor; pupils contracted; temperature,  $98.5^{\circ}$ ; pulse, 120; no paralysis or muscular rigidity; reflexes normal; fracture of left thigh. Clonic spasm of left side five hours after admission.

Death in ten hours after reception of injury. Hourly temperature, 100°, 101°, 102·4°, 102·4°, 103°, 104·4°, 105°, 106·4°. Thirty minutes post mortem, 108·8°.

CASE XLIX.—Male, aged four; fell two stories, striking the back of the head; small scalp wound just above external occipital protuberance; large hæmatoma above each ear; profuse hæmorrhage from both ears and mouth and hæmatemesis; depressed fracture could be felt beneath the wound; unconscious; right pupil dilated; neither pupil responsive; slight rigidity of muscles of right side. Temperature, 100·8°; pulse and respiration very rapid; respiration became Cheyne-Stokes. Died in four hours.

CASE L.—Male, aged fifty-nine; fell two stories through an elevator and struck his head; contusion about right ear and nose; unconscious for ten days; hæmorrhage from right ear and nose and under right conjunctiva; stertor; pupils irregular. At the end of a week restless, and required to be kept in bed by an attendant. Discharge from ear straw-colored. At the end of two weeks patient entirely conscious. Ten days later he walked a little and began to recognize people, and after another ten days he was mentally recovered.

CASE LI.—Male, aged thirty-three; thrown from a truck and received a blow upon the head; scalp wound in left temporal region; profuse hæmorrhage from left ear; pupils regular. He was semi-comatose, but conscious and rational, next day, and two days later became delirious. Hæmorrhage from the ear ceased on the sixth day, delirium continued a week, and vertigo for upward of three weeks. No further symptoms were developed.

CASE LII.—Male, aged thirty-five; struck on the head by a brick falling eight stories; not made unconscious; compound, comminuted, depressed fracture at right temporo-parietal junction; squamous portion of temporal much comminuted, and one large fragment driven into the brain; hæmorrhage from right ear and nostril; right pupil contracted; little or no shock. He recovered with some deafness remaining in right ear.

CASE LIII.—Male, aged thirty-five; fell down stairs while drunk; coma; stertor; hæmorrhage from left ear, which con-

tinued twenty-four hours: pupils contracted. Regained consciousness in twelve hours. Five days later, left facial paralysis, both upper and lower face involved, and food accumulated between cheek and jaw; ptosis, etc. No loss of sense of taste. He entirely recovered from paralysis, and suffered only from occasional vertigo.

CASE LIV.—Male, aged nineteen; thrown from his horse while riding, and struck on the back of his head; contused wound in right occipital region; profuse hæmorrhage from right ear; pupils contracted; unconscious till after his removal to his house, a distance of two miles. He then had severe nausea and vomiting, and was somnolent for several hours. The next morning his pulse and temperature were normal, and he suffered from severe pain in the head, which continued for three days. Hæmorrhage from the ear ceased at the same time. There was no rise at any time in pulse or temperature. At the end of ten days there was still some pain and tenderness on deep pressure just above and behind the ear. His recovery was complete.

CASE LV.—Male, aged forty-four; said to have fallen and been struck by a plank; admitted to alcoholic ward, and next day transferred to surgical service when he had partially recovered consciousness. The left upper and lower extremities, which had been rigid, had become hemiplegic and anæsthetic. There was an abrasion of the nose, a contusion of the left eye, and a hæmatoma of the right posterior parietal region. Three days later the left hemiplegia had become complete; movements from the bowels were conscious but involuntary; bladder controlled; temperature, 99°. His mental condition had been unchanged since he recovered consciousness. He answered questions rationally, and never varied in his explanation of the manner in which his injury had been received. He talked constantly and rambled in his speech. Upon incision, an open fissure was disclosed, which ran obliquely across the right parietal bone, from the anterior superior angle, and into the occipital as far as it could be conveniently traced. There was no depression. A large opening was made through the bone by trephining and use of the rongeur. An epidural clot was found to extend from the coronal suture in front to the superior occipital fossa be-

hind, and from the median line to the middle fossa, and was an inch and a half in thickness in its central portions. This clot, when removed, measured four ounces and a half by volume, and left a large cavity, the result of cerebral compression. The dura was apparently uninjured. As hæmorrhage was free from some inaccessible point beneath the bone, the cavity was temporarily packed with gauze. Two hours after the operation he could move the left leg. Twelve hours later there was sensation in the left arm. The next day sensation was perfect, movements of the left arm still restricted, and movements of the bowels occurred which were controlled. Temperature, 98·5°. The second day the brain had regained the volume it had lost by compression, and his mental condition was apparently normal. In four days he was in all respects entirely well, except for his external wound.

CASE LVI.—Male, aged twenty-three; thrown from his horse and sustained a depressed fracture of the left frontal bone two inches above the orbit. Partial loss of consciousness; hæmorrhage from nose and mouth; pupils normal; skin pale and moist, and extremities cold; two or three hours later projectile vomiting and hæmatemesis. There was slight ecchymosis of the left upper eyelid before the vomiting; after it both eyelids became excessively ecchymotic, and at the same time the outer half of the left conjunctiva became filled with blood. The temperature was usually about 99°, never above 100·5°. He had temporary amblyopia, and no other results followed.

CASE LVII.—Male, aged forty-five; knocked down and beaten about the head; lacerated scalp wounds in left fronto-parietal region; coma; hæmorrhage from both nostrils; pupils normal; pulse, 100. He recovered partial consciousness in one hour, and became excessively irritable; full consciousness returned next day, and he was removed from the hospital.

CASE LVIII.—Male, aged twenty-six months; fell four stories; extensive scalp wound in right occipital region; repeated vomiting; hæmorrhage from right ear. Three hours later he became restless, had clonic spasms upon the right side, and gradually lost consciousness. There was apparent complete



right hemiplegia: movements of the left side were easily induced; pulse 130 and weak; breathing stertorous. Consciousness gradually returned within twelve hours, and no paralysis remained. There were no further symptoms.

CASE LIX.—Male, aged thirty; fell from elevated railroad to sidewalk, striking upon left side of head and face; contusion over left eye; semi-conscious; hæmorrhage from *right* ear; pulse and respiration slow. The next day patient recovered consciousness enough to discover that he had become blind in the left eye. He responded slowly to questions and slept most of the time. Ophthalmoscopic examination of the left retina was negative. The left pupil would not respond to direct exposure to light, but would contract with the other pupil on simultaneous exposure. In the opinion of Dr. P. A. Callan, the blindness was due to pinching of the optic nerve by a fracture involving the optic foramen. Fifteen days later Dr. Callan found commencing atrophy of the optic nerve. Eight days after the injury there was partial left facial paralysis, and the tongue deviated to the right. He complained of pain over the left eye and behind the right ear. A slight sero sanguinolent discharge began to flow from both ears, continued for some days, ceased, and reappeared from the right ear. Temperature on admission was 99°, rose to 100°, and afterward varied, usually from 99° to normal.

The patient, a man of unusual intelligence, stated, after his recovery, that for five weeks after his accident he was unable to recollect the attendant circumstances or anything that happened about that time or afterward; that his mental condition was one of great confusion. After that period his memory was restored and his mental confusion disappeared. His recovery was ultimately complete, with the exception of the loss of sight of the left eye.

The diagnosis made was: Fracture of the frontal bone, commencing on the left side, extending through the anterior fossæ and through the right middle fossa and petrous portion, involving the left optic foramen and lacerating the prefrontal lobe.

CASE LX.—Male, aged forty-seven; was knocked down by a blow and his head struck heavily upon the pavement; slight con-

tusion upon lip and over right eye; pulse, 72; temperature, 100.2°; unconscious; stertor; pupils normal; soon became delirious and was unable to articulate. He remained in a condition of stupor and delirium for ten days; required mechanical restraint. He was unable to articulate, and was dysphagic; attempted to drink his urine. His mental condition and power of articulation then improved for two weeks, though he developed left facial paralysis, involving lower face; dysphagia disappeared. There was then an interval of a few days, when he was irritable, restless, and disposed to wander about the ward at night. His temperature varied from 100° to normal, and was usually at the higher point. From this time he became quiet and conversed intelligently, though his mind wandered. He had no recollection of his injury, of what preceded it, or of anything that occurred afterward. He failed to recognize his location or to appreciate his surroundings. His memory of more distant events was better, but still defective. His laugh was vacant, and there was some perceptible loss of power on the left side. He continued in a demented condition and incidentally a dipsomania till his removal to an insane asylum within the last month, two years after the injury.

CASE LXL.—Male, aged twenty-two; fell two stories and struck right side of the head and face and right shoulder; contusions of those regions and fracture of acromion; unconscious; hæmorrhage from right ear, and four hours later from the nose; regained consciousness in five hours; hæmorrhage from ear ceased in three days; temperature, 101° to 100°; normal after four days.

CASE LXII.—Male, aged twenty-two; fell three stories; contusions of right side of head, face, and eye; hæmorrhage from right ear and mouth; unconscious; pulse slow and full (60); breathing labored; temperature, 101°; pupils normal. Respiration soon became easier, but the patient was irritable and restless. He did not regain consciousness for five days, during which time he continued to be irritable when disturbed, and was not wholly rational for five days longer. Toward the end of the second week his articulation became thick and right lower facial paralysis became evident. At the same time a

swelling without discoloration of the left side of the face, which had been present since admission, perceptibly increased, but soon afterward disappeared. The facial paralysis persisted and the difficulty of articulation increased. His mental condition varied, but progressively deteriorated. There was slowness of perception and hesitation in expression. His laugh was silly and his manner vacant. There also seemed to be a sensory aphasia at a late period. In reply to questioning about the manner of his accident, he would talk about taking a basket of clams from Koster & Bial's. He might say "Koster & Bial's," but was quite likely to say "Koster and clams." At the beginning of the second month there was a sudden change. His mind in a day became clear; he knew where he lived and that he was in a hospital. He conversed rationally about his accident and how it occurred. He lost his delusions and rested quietly at night, though his speech was still a little indistinct and his facial paralysis had not entirely disappeared. Temperature after the third day was rarely above 99° and oftener below it. His recovery was ultimately complete.

CASE LXIII.—Male, aged forty; fell five steps of a stairway; walked home; hæmorrhage from right ear; had two convulsions next day and was then taken to the hospital; hæmorrhages from the ear still continued; stupid; muttering; two other convulsions, most marked on the right side, followed by mild delirium through the night. No previous history of epilepsy or excesses in drink. Temperature, 101·2°. Three days later patient was still stupid, said little and that incoherently, and was delirious. Temperature had ranged from 101·2° to 100·6°. He was transferred to Bellevue, and there became wildly delirious for three days, and then quiet and rational. Temperature, 98·8°. No further history noted; no other symptoms.

CASE LXIV.—Male, aged forty-two; cause of injury unknown. Semi-conscious and drunk; hæmorrhage from right ear which continued eight days; membrana tympani ruptured; violent mania for two days and mild delirium two days longer; temperature, 100°. Four days afterward he suffered pain in the head; had occasional delusions; his mental processes were slow, and his tongue deviated to the right; urine and fæces

incontinent. In the second week he became rational and only occasionally soiled the bed. His tongue still deviated. At the end of a month he no longer had symptoms; even the deafness had improved. Temperature second day,  $103^{\circ}$ ; gradual decline to  $99^{\circ}$  in four days. After seventh day habitually normal to  $99^{\circ}$ .

CASE LXV.—Male, aged forty; fell down a gang plank. Unconscious; hemorrhage from both ears, more from the right; pulse, 100; temperature,  $100^{\circ}$ . After some hours consciousness returned and he was able to speak. Delirious through the night. On the next day his tongue deviated to the right; pupils dilated, left more so than the right; mind still clouded; temperature,  $99.6^{\circ}$ . Four days later he was rational. No further symptoms.

CASE LXVI.—Male, aged twenty-three; walked out of a window while sleeping and fell three stories to a stone pavement below, striking an iron fence on the way down. He remained unconscious for fifteen or twenty minutes. On admission, there was a wound of the external right ear. While this wound was being dressed a very profuse serous discharge began from this ear and continued for several days. Pupils and respiration normal; severe vertigo, aggravated on attempting to arise or on opening his eyes; he vomited several times; pulse, 90; temperature,  $99^{\circ}$ . On the fourth day he had upper and lower incomplete facial paralysis which continued for a week's time. On the eighth day he had three epileptiform convulsions and one on the next day. The head and eyes were first turned to the right, then the arms and finally the legs were involved. On the twentieth day he began to have severe pain in the right ear, and as the mastoid region later became swollen and inflamed, it was trephined for exploration with negative result. The temperature but once exceeded  $99^{\circ}$ . The mastoid inflammation disappeared at once after trephination. Recovery was complete.

CASE LXVII.—Male, aged fifteen; kicked in the back of the head by a horse. No apparent external injury; profuse hemorrhage from right ear; was moaning and restless; became delirious after a few hours; afterward irrational and incoherent;



irritable; temperature,  $100^{\circ}$ ; delirious or irrational for five days; temperature,  $100^{\circ}$  to  $102^{\circ}$ ; removed from hospital in two weeks; temperature,  $99^{\circ}$ ; still had delusions.

CASE LXVIII.—Female, aged six; fell two stories to pavement; unconscious; lacerated wound over right eye and hæmatoma; contusion of face; severe hæmorrhage from mouth and nose and hæmatemesis; subconjunctival hæmorrhage in both eyes; pupils dilated; stertor; respiration frequent; temperature,  $99^{\circ}$ ; reflexes lost; incontinence of urine and feces; surface irritation caused violent convulsions; initial symptom in the eyes, continued twenty-four hours; also hæmorrhage from nose and mouth. After that time all the symptoms disappeared, and patient was out of bed on the tenth day; temperature rose in three hours from admission to  $103.2^{\circ}$ ; fell to  $98.6^{\circ}$  on the second day.

CASE LXIX.—Male, aged four; struck by some falling object; contusions over left frontal and right parietal eminences; hæmorrhage from mouth, nose, and both ears, and continued from left ear for five days; unconscious; left pupil dilated; left facial paresis; temperature,  $99^{\circ}$ ; somnolent forty-eight hours, but rational when roused; incontinence of urine and feces; temperature,  $100^{\circ}$  on second day and  $100.4^{\circ}$  on third day; did not get below  $100^{\circ}$  till tenth day; pulse usually 120; symptoms gradually disappeared.

CASE LXX.—Male, aged forty; fell one story to pavement, striking back of his head; scalp wound in right occipital region; hæmorrhage from left ear; left pupil dilated; soon became normal; unconscious; partially restored in ambulance; on admission, restless and delirious; temperature,  $99.4^{\circ}$ ; pulse, 60; respiration rapid; moved right side only; incontinence of urine and feces. Temperature ranged during the first week from  $100^{\circ}+$  to  $101^{\circ}$ ; then became  $99^{\circ}+$  in the morning, and at end of second week became normal; pulse varied from 62 to 54; required continuous mechanical restraint for four days and at night for one month. His mind underwent the typical changes (see remarks on diagnosis), and became ultimately completely restored.

## FRACTURES OF THE VERTEX.

CASE LXXI.—Male, aged fifty-two; fell backward and struck back of his head, at the same time fracturing his left patella. At the hospital to which he was taken his head injury did not attract attention. He was delirious on the second day and had a convulsion on the fifteenth, and his condition was attributed to the alcoholic habit. Six months later the patella was wired for non-union. His muscular rigidity under the anæsthetic was notable. His temperature the day following the operation was 99° till one o'clock p. m. Half an hour later and without premonition he had an epileptiform convulsion which began in the face and became general, and was followed by wild delirium. He had two other similar convulsions, also followed by wild delirium, and the last by a temperature of 103°. The kidneys acted freely and the urine was normal. The wound of operation was the seat of primary union. The temperature was normal on the next day and so remained for fifteen days. At that time an attempt was made to coapt the fragments of the patella, which he had torn assunder in his convulsions and delirium. This failed and there was some subsequent suppuration which elevated the temperature for the next ten or twelve days to 99° + to 102°. The wound was then healed and the temperature again became normal. At each dressing great muscular rigidity and tonic spasm had been noted in the affected limb (left). Just one month from the previous attack convulsions recurred and were frequently repeated for thirty-six hours. They were all marked by the same characteristics. Each one was preceded by great restlessness. In about fifteen seconds this was followed by wide dilatation of both pupils. The muscles of the left side of the face began to twitch and the eyes deviated to the left. The muscular spasm extended to the other side of the face, then to the left arm and leg, and finally became general. The whole convulsion lasted about thirty seconds. During the day the deviation of the left eye became permanent. The tendon reflexes were markedly increased. After the convulsions ceased he became delirious and died nine hours later. At the time of the seizure his temperature was 100·1°, in twelve hours it became

102°, in twenty hours 104°, in twenty-four hours 104·8°, and afterward fell to 104°.

*Necropsy.*—The knee joint of operation was found to be free from inflammatory complication, and the wound practically healed. A depression was discovered in the skull just above the external occipital protuberance in the median line. This was confined to the external table and no lesion of the brain existed beneath it. At the opposite extremity, however, of the antero-posterior diameter there was a circular laceration upon the anterior border of the right frontal lobe, and another laceration existed upon the under surface of the left frontal lobe, upon the middle of the second and third orbital convolutions, an inch and a half by an inch in diameter. A still larger laceration of the base, at least three inches and a half by an inch and a half in diameter, existed upon the right temporo-sphenoidal lobe, involving a little of the first, and almost the whole of the second and third convolutions. All these lacerations were distinctly limited, softened, and of a brownish color, showing the considerable time which had elapsed since they were inflicted. The whole right temporo-sphenoidal lobe was greatly atrophied, indurated, and pigmented. The pia was thickened over each laceration.

CASE LXXII.—Male, aged forty; cause of injury unknown; found unconscious in bed; contusion of forehead and left upper eyelid; pupils regular and fixed; right facial paralysis; both arms and right leg rigid; pulse, 96; respiration, 36. Twenty-four hours later, right arm paralyzed, but still rigid; could not determine whether right leg was paralyzed; pulseless; died in thirty hours; temperature at admission, 102·6; twenty-four hours later, 105°.

*Necropsy.*—Hæmatoma over whole left parietal region. Linear fracture across whole length of parietal bone just above temporal ridge, recurving upon itself posteriorly for a little distance. Large epidural clot beneath the fracture compressing and flattening the whole left hemisphere and forming an oblique plane. General contusion of the whole brain, which was hyperæmic and studded with minute extravasations.

CASE LXXIII.—Male, aged twenty-eight; received a blow

upon the head from a falling elevator (lift); compound comminuted fracture of right frontal bone; wound filled with clot and brain tissue; opening in the skull an inch and a half by half an inch in diameter. After cleansing the wound a cavity was left in the frontal lobe as large as a Mandarin orange. The patient was semi-conscious, but mental condition soon became normal. Pulse, 68; temperature,  $100.2^{\circ}$ . Vomited frequently. At the end of twenty-four hours he was rather heavy and somnolent, but could be easily roused, and was rational. Two hours later he was found in a comatose condition, with a temperature of  $105.4^{\circ}$ , and died soon afterward, twenty-seven hours from the time he received the injury.

*Necropsy*.—Two large fissures ran backward on either side of the skull, one terminating in the parietal and the other in the occipital bone. There was no epidural hæmorrhage. An irregularly shaped piece of the internal table was detached and rested upon the brain just above the cavity noted, but nearer the median line, and a subdural clot three inches in diameter and half an inch thick was situated just posterior to it upon the right frontal lobe. There was slight cortical hæmorrhage in the left occipital region. There was no lesion at the base. The cavity made by laceration of the frontal lobe extended nearly to the lateral ventricle. The whole brain, including the pons, optic thalami, and corpora striata upon both sides, and the cerebellum, was streaked with minute coagula, some of which, an inch in length, could be teased from the vessels.

CASE LXXIV.—Male, aged thirty-two; fell thirty feet into the hold of a vessel, striking upon his back. Unconscious; pulse and respiration slow; stertor; no other symptoms. Condition resembled that of alcoholic coma. Next morning the temperature was  $101.6^{\circ}$ ; evening,  $101.8^{\circ}$ . On the second day, A. M.,  $103.8^{\circ}$ ; M.,  $104.2^{\circ}$ ; P. M.,  $105.4^{\circ}$ . Right hemiplegia and both eyes turned to the left. Pupils normal. Pulse feeble and rapid. Respiration inadequate from pulmonary œdema. Still unconscious. On the third day temperature, A. M.,  $106.4^{\circ}$ . Death in sixty hours.

*Necropsy*.—Separation of coronary suture from right frontal eminence to its left external extremity. Not much epidural



hemorrhage. Laceration of posterior extremity of left temporo sphenoidal extending into occipital lobe. Consequent subdural hemorrhage of moderate amount, involving left motor area and occipital lobe to the base. Another laceration existed on the posterior border of the left cerebellum. General contusion.

CASE LXXV.—Male, aged thirty-two; fell from his truck. Contusion of left parietal region; unconscious; irritable when disturbed; temperature, 99°; pulse, 60 and full; coma continued for about a week with temperature from 99° to 100°, then a period of irritability and mild delirium which lasted two weeks longer. Mental condition after the first two weeks apathetic and weak. He answered questions rationally when spoken to, but rambled in his speech. He recognized his friends, but spoke only when spoken to and had some delusions. At the end of a month he was transferred to Mount Sinai Hospital and died there.

*Necropsy*.—Fracture found in left occipito-parietal region. Laceration.

CASE LXXVI.—Female, aged twenty-three; suicidal gunshot wound through right temporal fossa; median line of vertex presented a conical elevation; hemorrhage considerable; patient unconscious with stertor; coma became more profound; temperature fell to 95°; pulse rapid; death in four hours.

*Necropsy*.—Scalp infiltrated with blood. Bullet entered frontal bone a little above and external to right eye, penetrated the brain, passed inward, upward, and backward, and impinged upon the inner surface of the skull, a little to the left of the median line in the middle parietal region. It elevated two little triangular pieces of bone which remained attached to the pericranium. The bullet then fell back into the brain. It had entered at the anterior extremity of the fissure of Sylvius, traversed the right frontal lobe, just below the cortex and parallel to its curve, and then passed a little backward and across the longitudinal fissure below the longitudinal sinus, into the left parietal lobe; after fracturing the left parietal bone and falling back into its cerebral track as noted, it rested about half an inch below the surface. The skull was very thick and fissured from

the point where the bullet entered. There was little intracranial hæmorrhage.

CASE LXXVII.—Male, aged twenty-six; homicidal gunshot wound in right temporal fossa; patient unconscious; pupils normal; general muscular twitching; coma became profound, and death followed in twelve hours.

*Necropsy*.—Bullet entered just behind external angular process of right frontal bone, traversed the right hemisphere nearly in its antero-posterior diameter, just above corpus callosum, impinged upon inner surface of the occipital bone, and, rebounding through the opening in the dura, fell into the inferior occipital fossa. Considerable subdural hæmorrhage.

CASE LXXVIII.—Male, aged forty-two; suicidal gunshot wound in right temporal fossa; patient unconscious; pulse, 70; no other symptoms. He soon regained consciousness and was rational, but his mental processes were sluggish. He had syphilitic laryngitis and aphonia. Temperature, 99°. An attempt was made to remove the ball next day, the opening in the bone at about the right temporo-frontal junction having been enlarged by the trephine. The track of the ball could be traced about two inches and a half forward, downward, and inward, at which distance a piece of bone, carried inward by the ball, circular and comprising both tables, was discovered and removed. Considerable brain matter oozed out during this exploration. The ball was not found. No reaction followed the operation. The patient lived thirty days. His urine and faeces were voided freely, but without attracting his attention. The discharge of brain matter from the wound gradually diminished. At the time of his death the external wound had almost entirely healed. The most notable symptom in his condition was hebetude. He remained rational but quiet, listless, and taking no notice of people or things, and without interest in what went on about him, with occasional intervals in which his mind seemed brighter. The temperature ranged from 100° + to 103·6°, and was usually above 101°.

*Necropsy*.—The ball entered the brain about the middle of the third right frontal convolution, and passed nearly transversely through the center of both frontal lobes, and lodged

just behind the ascending arm of the fissure of Sylvius on the left side in the upper portion of the island of Reil. Its track passed just above the anterior horn of both lateral ventricles, and above the corpus callosum, just involving the callosal marginal convolutions. On the left side the track was sharply defined, and formed a cavity five eighths by seven eighths of an inch in diameter containing the ball surrounded by clot and brain detritus. This was separated by the median fissure from the cavity on the right side from which the bone was extracted during life. Between the two cavities was a minute piece of bone.

CASE LXXIX.—Female, aged eight, fell three stories: conscious; shock; compound comminuted depressed fracture of left frontal bone, with laceration of brain and meninges; restless and delirious; died on the third day; temperature on admission,  $100.2^{\circ}$ ; rose to  $104.6^{\circ}$ .

*Necropsy.*—Cavity in left prefrontal lobe filled with clot and brain detritus. No considerable intracranial hæmorrhage. General contusion of brain substance with coagula in minute vessels.

CASE LXXX.—Male, aged fifty; cause of injury unknown; unconscious; pulse and respiration rapid; temperature,  $100^{\circ}$ ; both pupils dilated; died in four hours.

*Necropsy.*—Simple fracture of left temporal bone, squamous portion. Deep laceration of right temporo-sphenoidal lobe, also of anterior border of left temporo-sphenoidal, smaller and shallower. Whole superior surfaces of both hemispheres covered by cortical hæmorrhage.

CASE LXXXI.—Male, aged sixteen; struck on the head by an iron wrench; scalp wound; depressed fracture at right parieto-occipital junction; trephined and elevated; no general symptoms; waking case; no injury of dura; no subsequent symptoms.

CASE LXXXII.—Male, aged thirty; struck on the head; compound depressed fracture of left temporal bone at parietal junction; temporarily unconscious; afterward dazed; agraphia; trephined and bone elevated next day; agraphia continued eight days; sensory aphasia on the third day; temperature on ad-

mission,  $99^{\circ}$ ; next day,  $103^{\circ}$ ; second day,  $103.8^{\circ}$ ; became normal on eighth day; afterward varied from  $99^{\circ}$  to  $102^{\circ}$  for twenty days; did not again become normal till thirtieth day.

CASE LXXXIII.—Male, aged thirty-three; blow from a cleaver; fragment of outer table of left frontal cut off and left hanging by the periosteum, including the frontal eminence; condition irritable; wound healed in four days; no subsequent symptoms.

CASE LXXXIV.—Female, aged two years and a half; fell down stairs; compound depressed fracture of left parietal bone just posterior and external to frontal eminence; wound lacerated and contused. Three days later, convulsion occurred and admitted to hospital. Wound suppurating and sloughy. No general symptoms. Bone elevated. Highest temperature,  $102^{\circ}$ . Discharged in twenty-eight days; readmitted fourteen days later; subdural abscess; hernia cerebri; abscess in brain evacuated; hernia subsided and patient discharged.

CASE LXXXV.—Female, aged forty-two; struck with a hammer weighing eight pounds; several lacerated and contused wounds of the scalp, and a depressed fracture of the posterior inferior part of the right parietal bone one half by three fourths of an inch in diameter, with a fissure running forward; haematoma over right malar bone and a contusion of the back of the neck; patient conscious, rational, and restless; pulse, 120 and full; temperature,  $99^{\circ}$ ; third day,  $100^{\circ}$ ; fourth day,  $104^{\circ}$ ; trephined and elevated; some epidural clot removed; dura tense and not pulsating, and was incised; small amount of blood and serum escaped; wound healed at once and temperature fell gradually to  $99^{\circ}$  in four days ensuing. Six months later, I was told by Dr. G. Douglass that he had seen her at about that time. She was very nervous, excitable, and complained that she was confused and "wrong in her head" ever since her discharge.

CASE LXXXVI.—Male, aged thirty-eight; was struck by a bottle in middle of forehead; he was dazed, but able to walk; compound depressed fracture of right frontal bone extending into orbital plate, and frontal sinus opened; trephined and a piece of bone, an inch and a half square, with a sharp edge,



which had penetrated the cerebral substance, was removed. The superior longitudinal sinus was torn, and hæmorrhage was controlled by pressure against the bone with one blade of a Langenbeck's forceps. Sutured in position till the third day. The patient for a time was irritable and delirious, requiring mechanical restraint. The temperature was very uniform, varying only from  $99^{\circ}$  to  $100^{\circ}$ , when it became normal.

CASE LXXXVII.—Male, aged forty; knocked down by a blow upon the head. When he recovered consciousness he walked into the hospital. Compound depressed fracture posterior to left frontal eminence, and piece of inner table driven in. Dura uninjured. No general symptoms. Temperature,  $101^{\circ}$  to  $102^{\circ}$  for six days, when it suddenly dropped from  $101^{\circ}$  to normal.

CASE LXXXVIII.—Male, aged fourteen; fell two stories; temporarily delirious from fright and excitement, and then recovered and walked home: depressed fracture in right frontal bone near coronal suture; elevated; no subsequent symptoms.

CASE LXXXIX.—Male, aged thirty; gunshot fracture of right frontal one inch above the zygoma; considerable hæmorrhage from wound and beneath the conjunctiva; right eye protruded so much that the lids could not be closed; no mental symptoms; temperature,  $99.5^{\circ}$  to  $104.5^{\circ}$ ; next day temperature  $104^{\circ}$ . The bullet opening in the skull was enlarged by the trephine, several loose pieces of bone removed, and the bullet felt near the optic foramen. The eye was then removed and the bullet extracted through the orbit, the dura having been first incised. The roof of the orbit was found to be much comminuted. Temperature remained high, and delirium and illusions continued for three days. The wound suppurated rather freely for the first month, and the patient often suffered from headache, which was always relieved by changing the dressings. He remained in the hospital for two months and was then discharged entirely well. The temperature for the first ten days was  $102^{\circ}$  to  $103^{\circ}$ ; for the next twenty days,  $100^{\circ}$  to  $101^{\circ}$ ; for the next ten days,  $100^{\circ}$ ; and the next ten days,  $99^{\circ}$  to  $99^{\circ}+$ .

CASE XC.—Male, aged eighteen; blow upon the head from

a hammer; conscious; compound fissured fracture in left parietal region; no depression; no symptoms.

CASE XCI.—Male, aged twelve; ran into an iron post; compound depressed fracture of right frontal bone, encroaching upon coronal suture in temporal region; slight escape of brain-substance; elevated piece of bone three quarters of an inch in diameter; no general symptoms of cerebral injury. Had no subsequent symptoms, except for a single day following the operation, when he responded slowly to questions.

CASE XCII.—Male, aged thirty-five; blow upon the head from an earthen mug; compound fissured fracture of external table of posterior part of left parietal bone; no general symptoms.

CASE XCIII.—Female, aged thirty-seven; struck by a brick falling from a roof; compound depressed fracture of right parietal bone, three quarters of an inch from median line, double comminuted. One fragment removed and the other elevated. No general symptoms either before or after the operation.

CASE XCIV.—Male, aged sixteen; thrown from a horse; compound depressed fracture of left frontal bone, just above superciliary ridge; conscious and irritable; temperature,  $99.8^{\circ}$ ; pulse, 60, full. A piece of bone, an inch and a quarter by half an inch, completely separated and driven in upon the dura, elevated and removed under ether. Had no subsequent general symptoms except temperature, which for ten days was usually from  $99^{\circ}$  to  $100^{\circ}$ , and a somewhat irritable mental condition.

CASE XCV.—Female, aged seven; fell one flight of stairs over the banisters; struck her head; unconscious; vomited. Became dull and stupid on the second day; next day admitted to hospital. Hematoma in left parietal region, and linear fracture, discovered by incision, confined to left parietal bone. Temperature,  $99^{\circ}$ . No subsequent symptoms.

CASE XCVI.—Male, aged thirty-two; stabbed in the forehead with a pocket knife. Three days later no general symptoms. Temperature,  $99^{\circ}$  to  $100^{\circ}$ ; pulse, 76. After incision, the knife blade could be seen broken off at the level of the surface of the bone, an inch and three quarters above left supra orbital ridge, and an inch and a half to left of median line. A button of

bone, which included the knife point in the center, was removed by the trephine. The point had penetrated the brain a quarter of an inch. Dura incised and closed by suture. No subsequent symptoms.

CASE XCVII.—Male, aged twenty; knocked down by a blow from a heavy stick; unconscious; linear fracture from just above left superciliary ridge, extending into parietal bone, and incised wound. No general symptoms.

CASE XCVIII.—Male, aged thirty-one; struck by a shower of bricks; compound depressed fracture of right parietal bone. Trephined, and loose fragment of inner table, half an inch square, removed. No general symptoms.

CASE XCIX.—Male, aged twenty-six; fell thirty-five feet from a scaffold; had been temporarily unconscious. A fragment of the right parietal bone, near its upper posterior angle, including both tables, had been torn out and was missing, two inches by one inch and three quarters in diameter. The inner table was comminuted, and fragments pressing upon the dura were removed. No fissures. Dura uninjured. No disorders of sensation or other general symptoms. Temperature,  $99^{\circ}$  to  $100^{\circ}+$ .

CASE C.—Female, aged forty-five; fell down stairway at elevated railroad station; unconscious. Admitted after five days. Haematoma over left eye, which had been incised; fissure, extending into frontal sinus, could be detected through the incision. The only general symptom was occipital headache for some days after the injury was received.

CASE CI.—Male, aged eight; kicked by a horse; compound depressed fracture of right frontal bone, just above frontal sinus and near the median line. Elevated on the fourth day. Dura uninjured. Opening in the skull which remained was three quarters of an inch in diameter. Had no previous general symptoms. Temperature, from  $99^{\circ}$  to  $99.8^{\circ}$ ; after the operation, rose in twenty-four hours to  $103^{\circ}$ , and in forty-eight hours to  $104^{\circ}$ . In the next five days it fell gradually to  $99^{\circ}$ , and remained  $99^{\circ}+$  for ten days following. Once during this time—on the fifteenth day—some serum escaped from the wound at the time of dressing. On the twentieth day some laudable pus

escaped, also at the time of dressing, and a probe was carried two inches and a half into the frontal lobe parallel to the orbital plate. The next day the dura was incised to the extent of the cranial opening, and from two to three ounces of laudable pus evacuated. The probe could be carried backward two inches and a half parallel to the cranial wall on the external aspect of the hemisphere, as well as two inches and a half parallel to the orbital plate. The temperature at this time was  $99.2^{\circ}$  and pulse 96. There were no general symptoms, except a little mental dullness or apathy and slight right lower facial paralysis. His general condition was also becoming asthenic. The cavity was irrigated and drained by tube. Temperature rose next day to  $102^{\circ}+$ ; became normal in a week. Facial paralysis entirely disappeared in ten days. Discharge ceased during the third week. Mental condition became normal, and nutrition rapidly improved after the first few days. There was a fungus, not larger than a hazel-nut, which spontaneously disappeared. The external wound was entirely healed in little more than a month, and no symptoms of any kind remained.

#### INJURIES OF THE ENCEPHALON.

CASE CII.—Male, aged forty-one; fell upon his face; contusions most marked on left side of face and eyes; violent delirium for two days. Temperature,  $103^{\circ}$  to  $104^{\circ}$ . On the sixth day again became delirious, and later unconscious and violently responsive to irritations. Temperature was at no time below  $100^{\circ}$ , and was  $103^{\circ}$  just previous to death, which occurred at the end of six days.

*Necropsy.*—Hæmatoma and small scalp wound in right parietal region. Thin cortical coagulum over left occipital lobe, extending into median fissure. Subarachnoid serous effusion.

CASE CIII.—Male, aged sixty; pushed down three steps of a stairway, and sustained minor superficial injuries. No head symptoms till the fourth day, when he had four convulsions. There was one the next day, and afterward they occurred with increasing frequency till his death on the eighth day. Each one began by twitching of the muscles of the face, with the head and eyes turned to the left, and these extended to the left arm and



finally to the left hand. The right side was not involved at all. Temperature on admission,  $100^{\circ}$ ; in twelve hours,  $103^{\circ}$ . From this time it varied from  $103^{\circ}$  to  $104^{\circ}$  till six hours before his death, when it became and continued  $105^{\circ}$ .

*Necropsy.*—No lesion of scalp or skull. Subdural hæmorrhage over whole right cerebrum, and extensive laceration of right temporo-sphenoidal lobe.

CASE CIV.—Male, aged thirty-two; fell upon the sidewalk; scalp wound in left occipito-parietal region. Admitted to hospital ten hours later. Conscious and rational, but dazed, and with extreme muscular tremor. Two hours afterward the patient had a general convulsion. From this time, during periods of about six hours, there would be a succession of convulsions, with intervals of unconsciousness or delirium, followed by an equal period during which he would remain quiet and rational. The convulsions were all general from beginning to end, without recognizable initial symptom. Died in two days.

*Necropsy.*—Scalp wound, as previously noted. No lesion of skull. Cortical hæmorrhage on the right side of the vertex, from anterior border of frontal lobe to posterior fissure of Rolando, and covering the temporo-sphenoidal lobe laterally and at the base. Deep laceration of right frontal lobe, through the cortex, upon anterior and lateral borders, and extending well into the parietal region.

CASE CV.—An unknown man was found in the street, leaning against a fence in an upright position, dead.

*Necropsy.*—Hæmatoma over right side of the vertex; no lesion of the skull; blood fluid and viscera generally much congested; area of contusion and laceration over greater part of left frontal and temporo-sphenoidal lobes; subdural hæmorrhage over whole left hemisphere.

CASE CVI.—Male, aged thirty; found unconscious and supposed to have jumped or fallen from a second-story window. Wound over right eye and fracture of the nasal bones; coma profound; stertor; pupils contracted. On the two following days the temperature rose progressively from  $101^{\circ}$  + on admission to  $104.5^{\circ}$ ; pulse full, respiration rapid. Patient could be roused by pressure on supraorbital nerve. On the third day

still deeper coma, dysphagia, continued irritability, and restlessness, and temperature still  $104.5^{\circ}$ . Death at end of four days; temperature,  $107.4^{\circ}$ .

*Necropsy*.—No lesion of skull; no meningeal lesions; small cortical hemorrhage over posterior part of left parietal lobe, and small laceration of brain at parieto occipital junction; both cerebra hyperæmic.

CASE CVII.—Male, aged forty; fell down stairs. Admitted to alcoholic ward and transferred to surgical service next day. Slight scalp wound above right ear; comatose, but later could be roused sufficiently to tell his name; temperature,  $103.4^{\circ}$ ; restless; hyperæsthetic; pneumonia discovered; died next day.

*Necropsy*.—Left lung pneumonic; lower lobe in second stage, upper lobe in first stage; no lesion of the skull: dura mater adherent to the calvarium; the left hemisphere on its upper surface was completely covered by an organized false membrane, which also dipped into the median fissure and covered its internal surface. This membrane was divisible posteriorly into two layers; it was thin anteriorly, but fully an eighth of an inch in thickness in its posterior part; its upper surface was smooth, non-adherent, and comparable in appearance to a section of raw beef; its inferior or cerebral surface was smooth, velvety, non adherent, and could be raised without injuring the arachnoid; it did not dip into the sulci; it was traversed by minute vessels and studded with some fifteen or twenty grayish, caseous, and partially calcareous nodules, varying in size from that of a robin-shot to that of a buckshot. Similar nodules were found in the basilar vessels, which were generally atheromatous. No recent lesion of the brain was discovered, except general contusion indicated by moderate hyperæmia and some capillary extravasations.

His wife subsequently stated that he had never lost a day's work by reason of sickness, and that he had never had even temporary loss of consciousness or paralysis.

CASE CVIII.—Male, aged fifty seven; fell from his cab: unconscious: large hæmatoma over left parietal region: respiration slow and stertorous double facial paralysis and cheeks

flapping; complete right hemiplegia and anæsthesia; temperature,  $99^{\circ}$ . Trephined over left motor area; dura pale, tense, and bloodless; no brain pulsation. After incision of dura, serum escaped freely and the quantity increased when the head was so turned as to drain from the base. No blood clot found. Temperature at time of operation had risen to  $103.4^{\circ}$ ; six hours later it had fallen to  $98.6^{\circ}$ . The patient had regained consciousness and could articulate, and gave his name and address. Hemiplegia not relieved. After twelve hours, pulsation in the brain returned and he could speak rationally and intelligently, though with difficulty. Two hours later still he had a slight convulsion and death followed in four hours. The temperature remained at  $98.6^{\circ}$  after the operation for fourteen hours, and it then rose steadily to  $104.6^{\circ}$  just previous to death. The lower face continued paralyzed and the respiration became frequent and insufficient.

*Necropsy*.—No lesion of skull; laceration of external border of right cerebellum anteriorly, from which clot had formed about circle of Willis upon anterior part of pons and in transverse fissure in front of left cerebellum; the vessels were atheromatous; the interior of the left occipital lobe was filled with clot which had completely broken down its structure; the left lateral ventricle was filled with blood which had broken through the septum into the right lateral ventricle and also communicated with the blood cavity in the occipital lobe.

CASE CLX.—Male, aged sixty-three; struck by some part of the machinery of his engine; no general symptoms; temperature,  $100^{\circ}$ ; wound in posterior parietal region in median line and curving to the right; contusion over left parietal eminence; temperature second day,  $103.2^{\circ}$ ; delirious in the night; temperature third day,  $101.8^{\circ}$  to  $101^{\circ}$ ; headache; fourth and fifth days, temperature,  $103.4^{\circ}$  to  $103^{\circ}$ ; no general symptoms; sixth day, temperature,  $106.4^{\circ}$ , pulse, 140; restless and irritable, but rational; weaker; died on the eighth day; temperature last two days from  $105^{\circ}$  to  $105.2^{\circ}$ ; post-mortem temperature,  $104^{\circ}$ . A few hours previous to death there was muscular rigidity of all the extremities, most marked on right side and especially in right arm. There was perforating ulcer of the cornea.

*Necropsy*.—No lesion of skull or meninges; no hæmorrhage; no lacerations; cortex of brain and meninges hyperæmic; brain substance moderately œdematous and minute vessels filled with coagula; this condition involved corpora striata, optic thalami, pons, and cerebellum, and was most pronounced on left side and at the base; no minute extravasations; both lateral and both inferior petrosal sinuses were filled with decolorized thrombus, extending into jugular vein on the right side; the thrombus was colored only near the torcular Herophili.

CASE CX.—Male, aged sixty; fell two stories to the sidewalk. Contusion of left eye and slight contusion just above it; temperature, 101·4; delirium; pupils and respiration normal; pulse, 114. Later symptoms: patient very irritable; cried out and tried to get away when touched, but replied rationally to questions; incontinence of urine and feces; delirium continued; died on the fifteenth day; temperature rose to 103·2° on the fifth day and then fell very gradually to 100°. The day before death it was 103·4°, was 103·8° five hours ante mortem, and 104·2° one hour post mortem. General symptoms remained unchanged.

*Necropsy*.—No fracture; subarachnoid hæmorrhage over both hemispheres, forming a sheet which was thickest about occipito-parietal junction on both sides; some subarachnoid serous effusion in left frontal region; general contusion, which was most marked on left side; hyperæmia and punctate hæmorrhages.

CASE CXI.—Male, aged forty-five; cause of injury unknown; found unconscious in the street and admitted to hospital after forty-eight hours; contused wound in right parietal region; muttering stupor; rigidity of left arm; right hemiplegia, which was incomplete, but most marked in right arm; pulse, 60; temperature, 101°. On the third day the rigidity of the left arm was increased, and the paralysis of right arm was complete; paralysis of right leg was nearly so; coma absolute; pulse, 128; temperature, 105°. Trephined over motor area and incised the dura. Pulsation of brain absent at first, but soon returned in some degree. His movements became freer, and he began to utter articulate sounds. Signs of sensi-



bility increased: pulse, 108: temperature still 105°. Died next day.

*Necropsy.*—Moderate subacute arachnitis over anterior two thirds of upper surface of right cerebrum; laceration of left temporo-sphenoidal lobe, excavating and filling with clot its whole interior structure. The hæmorrhage extended downward around the circle of Willis and upward upon the cerebrum, mainly upon the occipital, but also in patches upon the frontal and parietal lobes.

CASE CXII.—Male, aged sixty: found unconscious in bed: seemed to be in perfect health when he retired to his room on the previous evening. He was heard moaning: no evidence of injury could be discovered: stertor: pupils normal: rigidity of right side: pulse 120 and weak: temperature, 100°. On the next day the right side was less rigid: the second day he was comatose; temperature, 103·2°, and he died.

*Necropsy.*—No lesion of scalp or skull: large amount of serum under the arachnoid. There was a very soft elliptical area of disintegrated brain tissue an inch and a half by three quarters of an inch in diameter upon the anterior part of the left occipital lobe, near the median fissure. There was a similar area, smaller in size, on the under surface of the same lobe, but with disintegration less advanced, and containing a clot not yet decolorized. There was a red, firm clot beneath the latter and deep in the substance of the cerebellum of more recent formation. The temporal artery was atheromatous, but none of the basilar arteries were diseased.

CASE CXIII.—Male, aged thirty: fell down stairs: consciousness was lost, and only partially restored. He fell out of bed that night, and again the next day, striking each time upon his right side. Admitted to hospital that evening. No external evidence of injury except slight contusion over crest of right ilium. Rational, but slow to respond to questions: left pupil slightly dilated: temperature, 99°. The following day he again fell out of bed, and again the day after, always on the right side, and there was a constant tendency to move to the right side of the bed, which was quite level. Some left paresis and some difficulty in swallowing, which he referred to the left side

of the throat; transient facial paresis. The amount of paresis and the condition of the left pupil varied from day to day. His mental condition deteriorated; he was stupid, rambling in talk, delirious, apathetic, and had delusions. At first urine, and later faeces, were voided unconsciously. His temperature for ten days was  $99^{\circ}+$ ; it then began to rise and was  $100^{\circ}+$  to  $101^{\circ}$ ; pulse usually from 84 to 96, and respiration nearly normal. On the fifteenth day he was trephined over the right motor leg area, and a small subcortical cavity discovered, from which half a drachm of yellowish fluid was removed. This fluid was subsequently found to contain numerous leucocytes. There was no marked change in his symptoms after the operation. Temperature was a trifle lower— $99^{\circ}$  to  $100^{\circ}$ —till the eleventh day, when it rose to  $104^{\circ}$ , fell the next day to  $100^{\circ}$ , and rose again to  $104^{\circ}$ , when he died from asthenia on the twenty-eighth day after his admission.

*Necropsy*.—Large subarachnoid serous effusion compressing frontal lobes. General cerebral hyperemia and many minute vessels filled with coagula. The brain substance around the small cavity discovered during life was softened, stained a reddish-gray color, and it contained minute extravasations.

CASE CXIV.—Male, aged twenty-nine: was found unconscious in Central Park. He was taken to a hospital, sent to court charged with intoxication, and afterward admitted to Bellevue, still unconscious. Small contused wound in right frontal region; pupils slightly dilated; complete left hemiplegia and hemianesthesia; slight left facial paralysis; temperature,  $106^{\circ}$ ; pulse, 140; respiration accelerated; convulsions shortly after admission, which were repeated at frequent intervals; initial symptom in the mouth and face; arms and legs gradually involved; trephined over junction of right arm and leg areas by house surgeon: result negative; temperature two hours later,  $107.4^{\circ}$ , and three hours later still he died in a convulsion. The ventricle was aspirated in the operation; temperature forty five minutes post mortem, was  $109.4^{\circ}$ .

*Necropsy*.—Brain and meninges excessively hyperemic; a small tumor as large as a pea was found in right lower face area; the surrounding brain tissue was disintegrated, forming

a small cavity; no hæmorrhages; the viscera were generally soft and congested.

CASE CXV.—Male, aged thirty-seven; was found at the bottom of a stairway with his feet uppermost; unconscious; pupils contracted; muscular rigidity, especially marked in the legs; pulse rapid; stertor; died in two days without having regained consciousness.

CASE CXVI.—Male, aged twenty-six; thrown out of a wagon and struck his head; unconscious, but conscious on admission; contusion in left parietal region; became irritable, and later comatose; died suddenly five hours afterward.

CASE CXVII.—Male; struck by a cleat falling from aloft aboard ship; large hæmatoma covering whole right side of the head; unconscious; slight rigidity of left side; pulse full and slow; died in fifteen minutes after admission.

CASE CXVIII.—Male, aged thirty-two; struck with a shovel; contusion of the right posterior parietal region; pulse full and slow; temperature,  $100^{\circ}$ ; pain in back of the head; dilatation of left pupil; rigidity of flexor muscles of the arms; somnolence and restlessness. After twenty-four hours patient became stupid and mildly delirious; left pupil widely dilated; urinated unconsciously; left arm only moved when irritated; sensation slightly more acute on right side; dysphagia marked; left pupil irresponsive to light. His condition varied from time to time for the first two weeks; left pupil more or less dilated and more or less irresponsive to light; mind obscured and apathetic; some ptosis of left eye. After that time his mind became clear, and he could intelligently describe the manner in which he received his injury. Paralysis of the left external rectus; optic nerve and retina normal; perforation of left tympanum and puriform discharge; some left facial paralysis. He was discharged at the end of two months. His ptosis and external strabismus had disappeared, and there was only a perceptible trace of the paralysis of the lower face. His left hemiparesis and anæsthesia were no longer noticeable. He was dull and stupid, which his family said was his normal condition.

CASE CXIX.—Male, aged twenty-five; fell from a truck, striking his forehead; unconscious for twenty-four hours;

slightly delirious for two days: pain in frontal region after that time; temperature,  $100^{\circ}$ , followed by mild dementia, which continued till his discharge.

CASE CXX.—Male, aged twenty-one; fell sixty feet down an embankment; unconscious; afterward, violent delirium lasting a week; then admitted to the hospital, still delirious, but more quiet; suppurating scalp wound external to right frontal eminence; bone exposed; also double fracture of right inferior maxilla. The following day he had eleven epileptiform convulsions within two hours. Each one began with twitching in right hand and arm, extending to left arm and then to both legs, and finally a general convulsion was established. Face not much involved, but eyes deviated to the right. After these attacks he remained unconscious for one hour; the right arm was then found to be anæsthetic, and with the right leg parietic. The next day he had one similar attack, but he was more rational afterward and recognized his parietic condition. On the next day he had six convulsions within a little more than two hours, each one beginning on right side of the face and extending to right side of the body before becoming general, and the right arm was paralyzed for five minutes afterward. In the next few hours he had six others, one of which was confined to right side of the face.

He was then trephined over left face area and the opening freely enlarged. Dura tense and incised, but no lesion discovered. He was then trephined through the exposed bone on the right side without result. No further convulsions occurred. The next day he was entirely rational, and it was discovered that he was aphasic. Some difficulty in articulation previous to the operation was ascribed to the fractures of the jaw. He had both motor and sensory aphasia. Called his own name McNannold. He was discharged at the end of a month. His wounds were entirely healed, right arm still parietic, and mind clear. He had some hesitancy in speech, and the selection of words required a little time. His temperature ranged from  $99^{\circ}$  + to  $101^{\circ}$  during his whole convalescence.

CASE CXXI.—Male, aged twenty; cause of injury unknown; unconscious for a short time; scalp wound in left

parietal region near the mesian line, and a large hematoma just behind it in posterior parietal region. He had no general symptom, except nearly complete paraplegia with flaccid muscles and somewhat increased reflexes. There was no evidence of specific disease, and it was possible to verify the fact that no paralysis had existed previous to this recent injury. He was discharged at the end of six weeks and could walk fairly well. The diagnosis was cortical hæmorrhage from direct contusion of the brain, extending from left motor leg area across the median line into the corresponding area on the right side.

CASE CXXII.—Male, aged twenty-one; cause of injury unknown: found unconscious. Committed as drunk and disorderly, and sent to Bellevue as a case of alcoholism. He again became unconscious and was constantly crying out, but always a single phrase. He was restless and hyperæsthetic, and the muscles of both sides were generally rigid. There was a slight scalp wound in right temporal region; incision disclosed no fracture. The day following he was more quiet and the muscles were less rigid. Partial paralysis of the lower left face was developed. He became rational, but apathetic. Then there were two days more of active delirium, after which he again became quiet, but had delusions. He was coherent in speech, though voluble, loquacious, and silly. He had sensory aphasia and agraphia, and his memory of recent events returned; he thought, however, he was born in September, 1891—two months before. In notation at dictation he interpolated figures, as in writing 495 he wrote 490005. He could write two figures correctly, but not more. After his discharge he returned to the hospital some months later, and was noisy and excitable. Subsequent inquiry at the station-house made it probable that he was not intoxicated at the time of his arrest. He remained unconscious from early evening all night. When he was finally roused he made strenuous efforts to speak. He was only able to say "Peter," his first name, which he repeated again and again, and evidently strove to give his last name. Temperature, 100·2° on admission; from 100° to 101° for five days, then normal. After that time averaged 98·5° to 99·5°.



CASE CXXIII.—Male, aged twenty-one; cause of injury unknown; found unconscious in the street; contusion of left eye and wound over superciliary ridge. On admission, he looked about with a vacant stare, but could not be induced to speak. Next day he had delusions and failed to recognize his family. His subsequent symptoms were all mental. Memory of recent events lapsed. Never spoke except when disturbed, then answered questions intelligently but mechanically. For three nights he became violently delirious, and attacked his neighbor in the next bed; then he became quiet again, and began to manifest some interest in what passed about him. Two weeks from the time of his admission his condition suddenly improved, and he began to remember some things which immediately preceded his injury. For the ensuing two weeks it was mainly noticeable that he never suggested or carried on any sustained conversation, and that he laughed much and without due cause. In the next and final two weeks of his continuance in the hospital he ceased to laugh inordinately or causelessly, and his memory seemed to be restored in reference to matters up to the time he was hurt, and since his recovery of consciousness. The only abnormal indication in his appearance was a slightly weak expression in his face. Temperature on admission,  $99.2^{\circ}$ ; afterward from  $99^{\circ}$  to  $101^{\circ}$ .

CASE CXXIV.—Female, aged seventeen, fell three stories through a hatchway; contusion of left occipital region; no fissure found on incision. She was unconscious, with muscular rigidity of all the extremities, and was irritable when disturbed. She moved the right arm and left leg only. Temperature,  $100.2^{\circ}$ . Delirious on the fourth day, and noisy and excitable for several days afterward. There was left paresis and dilatation of left pupil on the tenth day, and at the same time incontinence of urine and faeces which continued eight days. Temperature was  $100^{\circ}+$  for the first five days,  $99^{\circ}+$  for next five days, and then became normal. It rose on the thirteenth day from  $99^{\circ}$  to  $103.5^{\circ}$ , and on the next day to  $104.5^{\circ}$ . For the next ten days it was usually from  $102^{\circ}$  to  $103^{\circ}$ , at which time she was removed from the hospital. She subsequently recovered. She was of bad constitution, had inherited syphilis, was deaf,

and had interstitial keratitis in both eyes, with loss of sight in one from opacity of cornea.

The following cases of idiopathic lesion are added to illustrate simulated traumatism :

*a.* Male, aged fifty five, fell upon the sidewalk, and, after rising and walking a short distance, fell again. Upon admission he had a small wound in the median line of the frontal region. He smelled strongly of spirits and was ascertained to be of intemperate habits. He was unconscious from the time he fell until he died, seven hours later. He was restless, and upon irritation had muscular spasm of both lower and upper extremities. He had incontinence of urine and feces, dilated pupils, and Cheyne-Stokes respiration. No paralysis. Temperature,  $103.4^{\circ}$ ,  $104^{\circ}$ , and  $105^{\circ}$ . It was subsequently learned that the scalp wound was received two days previously, and that the spirits of which he smelled so strongly had been spilled upon him in an effort to restore him to consciousness before admission.

*Necropsy.*—Chronic meningitis with great arachnoid opacity but no serous effusion. Basilar arteries extremely atheromatous. Both lateral ventricles enormously distended with very bloody serum. Clot extended through each posterior cornu. The right optic thalamus was swollen with clot which also filled the third ventricle.

*b.* Male, aged seventy-one, said to have accidentally fallen from a chair four days previous to admission; no loss of consciousness; subsequent delirium; required mechanical restraint till his death, twenty-four hours later; pupils contracted; posterior cervical muscles rigid; hyperæsthesia; retention of urine; temperature,  $102^{\circ}$ ,  $102^{\circ}+$ ,  $103^{\circ}$ ; pulse, 90 to 114.

*Necropsy.*—Abrasion of the nose. Dura mater adherent to the calvarium, and arachnoid to the brain. Little serous effusion. Some opacity of the arachnoid. Meningeal and cerebral vessels hyperæmic. Cortex softened.

The result of an analysis of the preceding cases may be expressed in a brief

## SUMMARY.

I. <i>Fractures of the Base</i> .....	70
Recovered .....	21
Died.....	49
Number of necropsies.....	35
II. <i>Fractures of the Vertex</i> .....	31
Recovered .....	21
Died.....	10
Number of necropsies.....	10
III. <i>Encephalic Injuries without Fracture</i> ....	23
Recovered .....	7
Died.....	16
Number of necropsies.....	13
Total number of recoveries.....	49
“   “   “   deaths.....	75
	—
	124
“   “   “   necropsies .....	58

## NECROPSIES.

I. <i>Fracture of the Base</i> .....	
Involving posterior fossæ.....	7
“   middle fossæ.....	6
“   middle and anterior fossæ....	9
“   middle and posterior fossæ...	11
“   anterior and posterior fossæ...	1
“   all fossæ.....	1
	—
	35
Total number involving middle fossæ...	27
“   “   “   posterior fossæ..	20
“   “   “   anterior fossæ...	11

*Complications.*

Laceration and resulting hæmorrhages.....	9
“ “ general contusion.....	6
“ “ meningeal contusion.....	6
“ “ thrombi, hæmorrhages.....	2
“ “ epidural hæmorrhages.....	6
“ “ meningeal contusion, epi- dural hæmorrhages.....	1
“ “ general contusion, epidural hæmorrhages .....	1
Contusion and abscess.....	1
General contusion and epidural hæmorrhage.	2
Meningeal contusion.....	1
	<hr/>
	35
From direct violence .....	31
“ <i>contre-coup</i> .....	4
<b>II <i>Fracture of the Vertex.</i></b>	
Involving frontal bone.....	4
“ parietal bone.....	1
“ occipital bone.....	1
“ parietal and occipital bone.....	1
“ parietal and frontal bone.....	1
“ temporal bone.....	1
	<hr/>
	9

*Complications.*

Laceration and resulting hæmorrhage.....	5
“ “ general contusion.....	2
“ “ atrophy.....	1
“ meningeal and general contusion..	1
General contusion and epidural hæmorrhage	1

III. *Injuries of the Encephalon without Fracture.**Varieties.*

Laceration and resulting hæmorrhage....	5
“ “ meningeal contusion.....	2
“ “ general contusion.....	1
Meningeal contusion.....	1
General contusion.....	2
“ “ and thrombi.....	1
“ and meningeal contusion.....	1
	<hr/>
	13

*In Fifty-eight Necropsies.*

Laceration and resulting hæmorrhage....	19
“ “ general contusion.....	8
“ “ meningeal contusion.....	8
“ “ epidural hæmorrhage.....	6
“ thrombi, and hæmorrhages....	2
“ general, and meningeal contu- sion .....	2
“ and atrophy.....	1
“ meningeal contusion, epidural hæmorrhage.....	2
	<hr/>
	48
General contusion.....	2
Meningeal contusion.....	2
General contusion and epidural hæmor- rhage.....	3
General contusion and thrombus.....	1
“ “ “ meningeal contu- sion.....	1
Subcortical contusion and abscess.....	1
	<hr/>
	10



Total number of cases in which injury was received by

<i>Contre-coup</i> alone.....	31
Direct violence alone.....	5
<i>Contre-coup</i> and direct violence.....	19
Unknown .....	2
Unrecorded.....	1
	—
	58

*Pseudo-injuries.*

Apoplexy .....	1
Arachnitis.....	1
	—
	2

In the majority of instances the subjects were males in adult life. Vocation, the blundering helplessness of inebrity, and the homicidal passion sufficiently account for the influence of age and sex in the production of these injuries.

*Fractures.*—It is a noteworthy fact that so many injuries of the head—nearly sixty per cent.—involve fracture at the base. I have ranked as basic fractures all those which have involved that region, even though beginning at the vertex, because it is upon the implication of the base that all the so-called characteristic symptoms depend. In fact, fractures of the skull which do not begin at the vertex are exceptional. I have found upon necropsic examination but four cases in which fracture at the base was not continuous with a fissure extending from the point upon the vertex at which the violence was inflicted. These four, which began and ended in the base, were evidently from *contre-coup*. That they were the result of violence acting directly upon the vertex was proved by the history of the injury, as well as by existent wound, contusion, or fracture. In neither one was there the slightest reason to suspect that the force

was transmitted through the spinal column. The greater frequency of fractures which extend to the base, when compared with those which are confined to the vertex, depends simply upon the fact that, under ordinary circumstances, the physical properties of bone are such that force, even when of crushing character, will not expend itself wholly upon the point of impact, but will extend to a considerable distance. That the fissure extends from vertex to base, and not from base to vertex, is proved, even in the absence of a history, by the mute evidence of the superficial injury, and by the narrowing of the fissure as it passes downward. The explanation of the fact that fracture through the middle is more frequent than through the other fossæ is equally simple. The experiments of Aran have shown that when any part of the vault is subjected to violence it is the corresponding part of the base which suffers. It follows that the central or parietal region is the one most exposed to violence, and it is corroborated by post-mortem examination.

Four cases, aside from those produced by *contre-coup*, are of special interest simply as fractures. The first is a separation of the temporal bone into its constituent parts—squamous, petrous, and mastoid—in an adult male, the result of an apparently inadequate cause. The specimen was shown to this association two years ago. The second was a comminuted fracture of nearly the whole occipital, the posterior part of both parietal, and the right temporal bones, in which the fragments were completely detached from each other. This, like the first, was occasioned by a fall in the street, and was accompanied by extensive injuries of the brain, sinuses, and membranes. The patient recovered partial consciousness, and lived for a week's time. The third involved all the fossæ on both sides from a fall from the mast-head, and the patient survived two hours. This case I believe to be the first on record in which all the fossæ

were involved in fracture. The fourth case was a wide separation of the coronal suture on both sides, occurring in an adult without concomitant fracture.

The most practical comment to be made upon fractures of the skull is that in themselves they are absolutely unimportant. It is only by their complications, immediate or remote, that they involve danger to life.

#### COMPLICATIONS OF FRACTURES.

The complications of fracture are hæmorrhages, thrombosis, lacerations, contusions, and paralyses. Their derivatives are meningitis, abscess, and atrophy. All of these may be produced directly from injury to the encephalon without fracture, with the exception of one form of hæmorrhage. If epidural hæmorrhage ever occurs without the intervention of fracture, I have never seen it in necropsies, or had reason to suspect it in recovering cases.

Fractures of the skull without complication are not only without importance or consequences, but they are devoid of symptoms. A simple fissure of the posterior fossa would probably be unsuspected, for symptomatic cervical ecchymosis is of the rarest occurrence. A simple fracture of the vault is often overlooked in the absence of pressure symptoms. In fracture at the base, displacement of the fragment does not occur, or is insufficient to occasion trouble, and when the patient survives, union, of course, is without provisional callus. The very general existence of complications, however, often of the gravest character, has given fracture of the base vicariously both an importance and a symptomatology.

The encephalic lesions which complicate fracture include all those which occur independently, and therefore may be considered at once, from a double point of view, as complications and as primary injuries.

## HEMORRHAGES.

*Epidural* hæmorrhage is perhaps the most characteristic complication of fractures. In moderate quantity from the osseous or smaller meningeal vessels, it is the usual source of the diagnostic hæmorrhages from the ears, nose, or mouth, and into the orbital and subconjunctival tissues. In larger amount and as a source of danger, it is derived from the larger meningeal vessels, notably from the middle meningeal artery. In at least two and possibly four cases it was the immediate cause of death. In a third, involving fracture at the base, life was saved by operation, although the clot removed measured four ounces and a half by volume. Such a case is in evidence that the brain-tissue is really susceptible of compression.

*Subarachnoid or cortical* hæmorrhage is ordinarily derived from laceration of the cortical substance, and is often the direct cause of death, as well as of certain of the precedent symptoms. From a laceration at the base, whether of the frontal or temporo-sphenoidal lobe, it may cover the whole superior surface of one or both hemispheres, and cause various localizing symptoms which accompany or precede those of fatal pressure. From a laceration of the occipital lobe or cerebellum, it may cause immediate death from compression of the medulla: or the hæmorrhage from the torn vessels of the brain, even in extensive laceration, may be insufficient to seriously modify symptoms or hasten the fatal termination. A moderate amount of cortical hæmorrhage from rupture of the vessels of the pia is also one of the results of meningeal contusion.

*Subdural hæmorrhage* I have found most frequently to depend upon rupture of the arachnoid and escape of blood from the meshes of the pia mater into the arachnoid cavity. In a smaller number of instances its source has been in

the meningeal vessels. In a recent case there was rupture of the dura mater, and the blood was of epidural origin. Cortical hæmorrhage, however, is, of all others, the one most frequently encountered. The majority of lacerations reach the surface of the cortex, and superficial hæmorrhage results.

#### THROMBOSIS OF THE SINUSES.

The occurrence of thrombi in the sinuses of the dura mater and base of the skull in three cases, under varying circumstances, is not in all of them susceptible of adequate explanation. In the first case, which, like the second, involved fracture at the base, the posterior part of the skull was subjected to crushing violence. There was extensive epidural clot, large subdural clot which filled the right inferior occipital fossa, and a firm cortical clot beneath the seat of fracture surrounded by an inflammatory exudation. The surface of the posterior part of the right occipital lobe was softened and the seat of minute extravasations. There were small lacerations of the inferior surface of both frontal lobes, and one of considerable size in the right cerebellum, beneath the thickest part of the subdural extravasation. The wall of the posterior part of the superior longitudinal sinus was infiltrated with blood, and the cavity occupied by a thrombus. A second large and partially decomposed thrombus was situated in the torcular Herophili, and extended through the right lateral and petrosal sinuses into the jugular vein. In the second case a simple fissure extended from the right parietal bone into the posterior fossa, terminating in the jugular foramen. There was slight epidural and considerable subdural hæmorrhage at the origin of the fracture. There were several lacerations in the anterior part of the brain, and on the left side the interior of the temporo-sphenoidal and that of the frontal lobe were excavated



and distended by a clot from a hæmorrhage, which had also broken through into the lateral ventricles and occipital lobes and filled them with fluid blood. There was cortical hæmorrhage at the base, which had surrounded the optic chiasm and extended to the anterior border of the pons. The thrombus occupied the torcular Herophili and extended through the lateral and petrosal sinuses into the jugular vein. In the third and final case there was no fracture, intracranial hæmorrhage, or laceration. There was, however, general contusion, with moderate œdema and distention of the minute cerebral vessels with coagula. This condition extended to the corpora striata, optic thalami, pons, and cerebellum, and was most pronounced at the base and upon the left side. The thrombus was decolorized, and occupied both lateral and both petrosal sinuses. It extended into the right jugular vein, and was colored only near the torcular Herophili. I have detailed all the accompanying lesions, though I do not believe that they were all related to the formation of the thrombi. In the first case the infiltration of the wall of the sinus points to its laceration by direct violence as the first step toward the coagulation of its contents. The portion of the sinus in which it began was, moreover, directly beneath the point at which sufficient violence was inflicted to comminute the skull, to rupture its membranes, and to cause localized inflammation in connection with the hæmorrhage. The surrounding inflammation might, at first sight, suggest an inflammatory origin, but the absence of inflammatory products in the sinus wall corroborates the view I have taken. It is more difficult to account for the thrombus in the second case. There is no positive evidence, but a possible clew exists in the termination of the fissure in the jugular foramen. It may be that some injury done to the vein led to the beginning of thrombosis at this point. It had no evident relation to the other

intracranial lesions which can aid in solving the problem. In the third case the thrombus was the only localized lesion, and again a different and conjectural explanation must be sought. There was general contusion and general thrombosis of the minute cerebral veins. It is impossible to assume either that venous canals of such size should have primarily participated in the effect of a general contusion, or that the obstructing coagula should have extended secondarily into the sinuses. It might more naturally be assumed that the thrombus, which was already decolorized, was an antecedent lesion which had led to the venous obstruction and œdema of the brain tissue. There was, however, no indication of previous disease, and the man was at his work when struck down by the blow which caused his death. These cases are pathologically independent of each other, and may have no significance in symptomatology or treatment. In another case I suspected thrombosis of the internal jugular vein, on account of an œdema of one side of the face and neck, but his recovery precluded a confirmation of my suspicion.

I am unacquainted with any similar instances of traumatic thrombosis of these sinuses. They were unconnected with pressure or any inflammatory process within or without their walls, or with any dyscrasia of the patient. In the first and second cases I have been able to suggest an explanation; in the third case I am still without definite opinion.

#### LACERATIONS.

Lacerations and contusions of the brain are unquestionably first in frequency and importance among all the injuries of the head. They play a part in all fatal cases, and dominate the symptoms in almost all cases of recovery. Even when death is the immediate result of hæmorrhage or inflammation, or when, though life be saved,

the mind is lost, they still ride behind. In every fatal case, with fracture or without, where necropsy has been permitted, one at least of these lesions has been found to exist. In every one in which necropsy has been denied, as well as in every case of recovery, the interpretation of symptoms in the light of what has been disclosed by previous post-mortem examination has pointed to the same conditions. They do not occur, however, with equal frequency. While in fifty-eight cases there were forty-eight with lacerations, there were but thirty with marked contusions; or, differently estimated, there were twenty-eight cases of laceration without noticeable contusion, and but ten of contusion without laceration. The lacerations may be single or multiple; they may be confined to the cortex, or extend a variable distance into the subcortical structure; they may originate subcortically and completely disintegrate the interior of a lobe without encroaching upon the cortex, or they may reach the pia; they may lacerate the pia and rupture the arachnoid, with or without diffusion of hæmorrhage, or the membranes may remain intact. In a large proportion of cases the laceration will be with well marked diffusion of hæmorrhage. Topographically, there is no lobe or convolution which may not be wounded. It will be seen from the necropsies recorded that the base of the brain, especially upon the frontal and temporo-sphenoidal lobes, suffers most seriously and most frequently, and that the interior of the frontal lobes is oftenest the site of extensive destruction. Several cases will be noted in which the hæmorrhage from a lacerated frontal lobe has broken through the lateral ventricles into the posterior regions of the brain. I present a specimen of small laceration in almost the exact center of the cerebellum (Case XXXIV). I have no record of laceration of the optic thalami, fornix, velum interpositum, or corpus callosum, though such injuries have been described.

I also present a specimen of laceration of the pons (Case XXVI). Instances of laceration of the corpora striata and gyrus fornicatus are included in the series (Cases XX, XXIX, XXX, XXXV). The general appearances of these lacerations have been noted by previous writers under the name of contusions, and they require but cursory mention. As they present themselves in the cortex, they are simply lacerated wounds containing more or less coagulum with underlying shreds and granular detritus of brain tissue. After the removal of the coagulum the bottom of the wound is usually pultaceous, and stained with blood or of a grayish color. Sometimes the peripheral brain tissue is softened and dotted with miliary extravasations, and sometimes it is of normal consistence and appearance. It is rarely the case that there is not some resulting hæmorrhage which infiltrates the pia, perhaps trivial in amount, perhaps sufficient to thickly cover the base or vertex and the lateral aspects of the brain. The wound may be circular, oval, or irregular in outline, not larger than a pea, or covering the whole extent of the inferior surface of the temporo-sphenoidal lobe. In case of subcortical laceration the lesion may be a simple extravasation of blood into the deeper brain tissue, as small as in the specimens from the pons and central cerebellum which I have just exhibited, and either as harmless as it is trivial in extent or of deadly import. In another instance, as in more than one of the necrologies which I have just recorded, the whole internal structure of both frontal lobes may be disintegrated and destroyed; and when the clot and mangled brain have been turned out, nothing but the cortical shell remains.

The subsequent changes which these wounds undergo are not numerous. If of considerable size, death ensues in the majority of cases before sufficient time has elapsed to permit any change of importance. The end to be hoped

for, as in any wound with loss of tissue, is cicatrization. In an experience in the dead-house lasting over many years, it has not been my fortune to meet with an instance of such reparative process, yet I have seen many cases of recovery where I am positive laceration had existed. There is a remarkable illustrative specimen in the Museum of St. George's Hospital, quoted by Mr. Hewitt, in which two large lacerations of the cerebrum, occurring without fracture, had cicatrized after many years. The cerebral surface was excavated and the pia and arachnoid were carried over the depression, leaving a cavity filled with loose areolar tissue and serum. The man's intellect had been clear, and he had suffered no cerebral symptoms.

If the patient survives, the process of reparation is evidently slow. In certain cases in which old lacerations were discovered after death from more recent injury, there was no contraction of the wounds and no inflammatory changes of importance had begun. The edges of the wounds were slightly rounded, and the coagula which they contained were softened and their color had become rusty or yellow.

In necropsic cases of recent laceration an interval of from a few moments to one day, or several, has probably elapsed. The appearances are practically the same whatever the interval may have been. There is no tendency to meningeal or visceral inflammation in any cases which I have observed, with the exception of the occasional formation of abscess from subcortical laceration. As in the case of general contusion, with profuse oedema and death after fifteen days, no inflammatory changes have been discovered even upon careful microscopical examination. In an exceptional case (Case VII) the temporo-sphenoidal lobe had been seriously lacerated, and after the lapse of six months was the seat of interstitial inflammation and atrophy.



## CONTUSION.

Contusion may be regarded as occurring in three forms—general and limited, affecting the brain, and meningeal, involving the membranes. The limited form may be either cortical or subcortical. Any two or all three of these may coexist in the same case.

Limited contusion of the brain differs from laceration as a contusion elsewhere differs from a wound. There is no palpable solution of continuity in the brain fibers, and consequently the hæmorrhagic extravasation can only be minute in quantity and of punctate or miliary form. In reparation only absorption, not cicatrization, is required, and recovery should occur in the major and not, as in laceration, in the minor proportion of cases. It is therefore less frequently met with in post-mortem observations. As in cortical or subcortical laceration, either form of limited contusion occasionally results in abscess. In the subcortical forms it may be difficult or impossible to determine which one of the two is the responsible lesion. I have very carefully described such an abscess in a case reported in the *New York Medical Journal*, March 19, 1890, and included in the present series. This abscess, which complicated fracture at the base, and two others complicating compound fracture of the vertex, comprise the small proportion of cases which represents the danger of this form of inflammation. In the case first mentioned, though fracture at the base existed and made it technically one of that class, there was also compound fracture of the vertex in connection with which the abscess was formed. So we may properly consider all the abscesses as complicating the latter form of fracture. In all three cases the dura was carefully examined at the time of accident and found to be uninjured, and after an interval of more than two weeks with-

out the occurrence of meningeal inflammation, the abscess was developed. In each the external wound had been healthy and had nearly closed. These data seem to prove that suppurative inflammation of the brain substance is the result of primary injury of the brain itself, and not secondary to meningeal inflammation extended from the point of fracture. The time for cortical and meningeal suppurations passed with the coming of aseptic methods, and at the same time hernia cerebri practically disappeared from the field of surgery. These cases, however, show that compound fractures still sustain a relation to deep abscess. It is not dependent upon the extent of the attendant laceration or contusion, for that is likely to be as great under other circumstances. It is more probably due to exposure, for, though uninjured, the dura and cortex may not be impervious to atmospheric influences. The explanation of this subcortical suppuration is, at all events, neither more nor less difficult than that of subcutaneous suppuration upon the surface of the body. The dogmatic assertion that traumatic abscess of the brain never occurs except there has been wound of the scalp or fracture of the skull is erroneous. Though the cases which I record here conform to this proposition, I am cognizant of at least two cases which do not. One was a small parietal abscess which I saw some years ago; the other an abscess of enormous size in the frontal lobe from a blow received in the ball-field, without the occurrence of superficial injury of any sort beyond moderate contusion. The latter specimen is still in the Museum of the Carnegie Laboratory. The important fact in connection with cerebral abscess at the present day is that it occurs from direct brain lesion independent of injuries of the scalp, skull, or meninges.

*General contusion* of the brain is more frequent than the limited form, but much less frequent than laceration.

I am accustomed to recognize it in three post-mortem conditions: General hyperæmia, with or without œdema, punctate or miliary hæmorrhages, and thrombosis of the minute cerebral vessels. They occur separately or together. Examples of each are afforded by the necropsies I have described, and the appearances they present are sufficiently indicated in the enumeration of post-mortem conditions which I have made. I will only refer to two very recent cases (Cases XXXIII and XXXIV) as well-marked instances of excessive general hyperæmia from general contusion accompanying laceration, and to one other (Case XXIV) in which death was due to general contusion with œdema. The very moderate hyperæmia which often exists in connection with other lesions I have not specially considered, though it may be of serious importance.

*Meningeal contusion*, as a distinct complication, occasions hæmorrhage and inflammation. Its relation to general contusion of the brain is not closely defined. The two conditions occur together or separately, and severity of one when they are coincident is not always proportionate to that of the other. I may instance as illustrative of this uncertain relation two cases—the one of œdema to which I but just now referred, in which the brain tissue was sodden and the ventricles distended with serum, while the meningeal vessels were but slightly congested and the sub-arachnoid spaces notably dry; the other, my single case of acute arachnitis to which I shall refer later, in which the whole subcortical tissue was very markedly hyperæmic and the smaller vessels filled with coagula. I do not regard simple meningeal hyperæmia as other than a factor in the more important lesion of laceration or general contusion, with which it may happen to be associated.

Hæmorrhage is of frequent occurrence. The vessels of the pia are ruptured and the blood is effused ordinarily in

a rather thin sheet over one or both hemispheres, but may present itself in patches scattered over any part of the brain. When the hæmorrhage is more profuse and the clot thicker, it can probably be traced to its source in a cortical laceration. The coexistence of both forms of cortical hæmorrhage is not infrequent. If the fact be fully recognized that cortical hæmorrhages of traumatic origin, unconnected with cortical laceration and without fracture as well as with it, are the result of meningeal contusion, the subject will not require further comment.

*Traumatic arachnitis*, so far as these records show, does not result from direct injury transmitted through fracture of the skull, nor from an inflammatory process propagated from a cortical laceration. This complication was once supposed to be the great danger to be feared from injuries of the head, and when death ensued it was always charged with the fatal result. An examination of the fifty-eight post-mortem observations I have made discloses only seven cases in which it was possibly present, and only five in which it was positively determined. Two of these occurred in connection with fractures at the base, and the remainder in simple injuries of the brain in which no fracture existed. One of the former was an acute arachnitis; the other six were characterized by a subarachnoid serous effusion. They all negative the theory of direct violence, or of an extension of a prior inflammatory process. The acute arachnitis (Case XVIII) was localized in the right and left occipital regions, while the attendant fracture and subcortical lesion were in the parietal region of one side, and separated from it by an interval in which there was no purulent effusion. General contusion was also present. In the case of subacute arachnitis which complicated a fracture at the base (Case IV), the depressed portion of the fracture which was in the vertex was con-

fined to the external table, the local lesion was subcortical, and there was evidence of general contusion. In the five other cases, in which there was more or less evidence of subacute arachnitis, there was no fracture at all; in three there was no laceration, but general contusion or cortical hæmorrhage from meningeal contusion; in one of the other two the subarachnoid effusion was localized on the opposite side of the brain from the site of the laceration; and in the other and last of the series the lacerations were old and considerably antedated the immediate cause of death. There can be no doubt that all of these were the result of meningeal contusion.

*Paralysis.*—Another complication which has been supposed to be a direct result of fracture is paralysis from bony compression of the cranial nerves. This condition is represented in a single case. In this there was compression of the optic nerve. There was fracture extending through both anterior fossæ, involving the left optic foramen, and pinching the optic nerve at that point (Case LIX). Loss of sight was immediate, and ophthalmic examination showed the condition of the nerve and eye to be normal. Subsequent examinations discovered progressive atrophy. The patient recovered, but loss of sight was permanent. In other cases in which loss of function occurred in parts to which cranial nerves are distributed, as elucidated by post-mortem examination, the cause was found to exist in lesion of the cortical centers or in compression of the nerve by blood effused into its intra-osseous canal of exit. There is so little displacement in fracture of the base that such instances as the one detailed are probably of great infrequency.

#### CONTRE-COUP.

I have called attention to the fact that fractures are usually the result of direct violence, expending its force



upon the vertex or transmitted in continuity to the base, and that fractures by *contre-coup* are exceptional. Lacerations and contusions of the brain, on the contrary, are almost invariably produced, either wholly or in part, in this way. In the minority of cases in which some encephalic lesion exists directly beneath the point at which violence has been inflicted, there has usually been further and more serious damage done to the brain in some distant part. There has been either laceration or general contusion discovered in each case subjected to post-mortem examination. If the cases of gunshot laceration are excluded, and also those of general contusion in which a question might arise as to the kind of violence to which the lesion should be ascribed, there are only five instances in which the violence inflicted was exclusively direct. It is almost safe, therefore, to assume in any given case that if a lesion of the brain exists, it has been produced by *contre-coup* at a distance from the seat of direct injury. A careful examination of the cases cited shows this distant point to be almost always upon the opposite side of the brain, and confirms all previous observations that it is likely to be at the base in the middle or anterior lobe. The reasons which have been adduced to explain the frequent occurrence of brain injury by *contre-coup* and its seat by preference have no relation to these necropsies and need not engage our consideration.

#### CONCUSSION AND COMPRESSION.

All traumatisms involving brain symptoms were for many years classified as cases of concussion or compression. The classification was undoubtedly simple and of easy comprehension. If the intracranial space was diminished by the intrusion of bone, serum, extravasated blood, or pus, it was compression. Otherwise all symptoms were referred to a hypothetical vibration of the brain within the skull, a merely

functional disorder produced by violence. Twenty years ago Mr. Prescott Hewitt described several forms of contusion, in which he included lacerations, and questioned the occurrence of concussion as a distinctively pathological condition without the existence of anatomical change. Previous to this time several observers had noted structural changes in certain fatal cases, but had not regarded them as either necessary or invariable. Some years later von Bergmann, in a clinical lecture, admitted the existence of both concussion and compression, with an aetiological difference, and insisted upon their clinical identity. He attributed concussion to a direct injury from a single impulse, modified by the elasticity of the skull, by which the brain suffered a diffuse disturbance of nutrition without appreciable lesion. He considered it a suspension of cortical activity followed by a stimulation, and eventually by a depression of the medulla. He recognized it as occurring in three degrees: 1. Involving paralysis of the cortex only. 2. Paralysis of the cortex and stimulation of the medulla. 3. Paralysis of both cortex and medulla, with brief and unobserved medullary stimulation. Cortical paralysis was indicated by unconsciousness; medullary stimulation by slowness of pulse and increase of arterial tension; and medullary paralysis by rapidity of pulse and decreased arterial tension. In compression, he regarded the brain condition as being identically the same, and as manifested by the same symptoms, but due to change of cranial capacity and not, as in concussion, to change of cranial form. Finally, he considered diagnosis as only possible by the duration of the symptoms. This clinical lecture was admirably translated by Dr. John C. Schapps, late house surgeon at St. Vincent's Hospital, and appeared in the *Annals of Surgery* in 1882. The views of von Bergmann, of which I have presented a *résumé*, are of great weight and authority, and probably

represent the cumulation of thought and observation up to that time. I do not know that very much of importance has been added since. I am quite in accord with his opinion that concussion and compression should be regarded as one, but would go further, and, having consolidated the two, would abolish them both together, so far as they are terms used to express a pathological condition. The difficulty with all explanations of concussion is that, of necessity, they are largely theoretical. To account conclusively for unseen pathological changes, or to authoritatively deny their existence, requires that the syllogism be very carefully constructed. In this instance, in every fatal case where the clinical history has corresponded to that of recovering cases a carefully conducted necropsy has revealed organic lesion. In all cases that have been cited to prove that no post-mortem lesion exists not one has been observed with sufficient exactitude to make it of the slightest statistical value. There is nothing in analogy to warrant at the present time the assumption that any fatal disorder terminates without involving structural change. Even disorders of the nervous system, long considered functional, have with closer investigation fallen more and more into line with organic diseases. It is tenable ground, therefore, to hold from both negative and positive post-mortem observation, as well as from general analogy, that brain injury produces structural change with the same certainty that it occasions palpable symptoms. If the terms concussion and compression be used to indicate a group of symptoms, or a variation of pathological condition, it is objectionable, both on the score of propriety and as being likely to lead to erroneous diagnosis. If they be discarded, the form of injury the patient has suffered in a given case—as laceration, general contusion, or fracture with hæmorrhage—is more likely to be accurately determined than if attention

be directed solely to a symptomatic condition that may not clearly exist. If unconsciousness and variation of pulse be accepted as the sole pathognomonic and invariable conditions of traumatism, there will still remain many cases of uncertain status. Examples may be cited from the foregoing necrologies in which, from the earliest moment at which the patient could be reached, there was neither unconsciousness nor a typical variation of pulse. There can be no doubt, however, that unconsciousness is one of the earliest and most constant symptoms of serious brain injury. The opinion that consciousness resides in the cortex as a whole, and that unconsciousness is paralytic or inhibitory, is confirmed by the negative results of physiological experiment and by the artificial production of cerebral anæmia. It may properly be regarded, therefore, as symptomatic of brain injury with diffuse effect, but not necessarily of diffuse injury. The primary retardation and subsequent acceleration of the pulse which have been experimentally proved to be attributable to medullary lesion are not as constant, and consequently of less symptomatic importance. In a majority of cases, at the first moment assistance can be rendered, the pulse is accelerated as it would be in serious injury of other parts of the body. The ambulance service is exceedingly rapid, so that if the retardation of the pulse is so evanescent as a symptom, it has no great practical diagnostic value.

The temperature, which has not heretofore received attention as an important factor in the genesis of symptoms or in the diagnosis and prognosis of brain injuries, seems to me of primary importance.

Analysis of the temperatures which have been recorded in these histories confirms the impression which I formed early in my study of these cases—that an elevation of temperature was an early, continuous, and very constant symp-

tom in all classes of head injury. I have a record of temperatures in 45 cases in which the diagnosis was confirmed by necropsy as well as in 10 other fatal cases and in 28 cases of recovery, a total of 83 out of 124 altogether. I think there can be no doubt of the propriety of including the cases of death without necropsy and the recoveries, since the diagnosis was in each well established. I have a definite recollection that in a considerable number of other cases in which the temperature was carefully observed and recorded, but in which the charts were unfortunately lost, that the averages were not essentially different.

Four cases, which proved to be fatal, were admitted with subnormal temperatures—from  $94^{\circ}$  to  $98^{\circ}$ . In two a subsequent rise in temperature was immediate, continuous, and very considerable; in the other two death ensued in a few hours without reaction—in all the pulse indicated medullary paralysis, and the lesions were afterward found to be extensive and severe. In six other cases the patient was not admitted to a surgical ward till the second day or later after the reception of the injury, so that the first temperature taken could not be considered primary, but in each case it was then notably elevated—from  $101^{\circ}$  to  $104.8^{\circ}$ . In one recovering case of fracture of the base with epidural hemorrhage it was normal, and never exceeded  $99^{\circ}$ . In the remaining seventy-two cases, without exception, the temperature on admission was above normal. In the majority it exceeded  $100^{\circ}$ , and ranged all the way from  $98.8^{\circ}$  to  $106^{\circ}$ . It would be difficult to trace a relationship between the character or location of the lesion and the comparative elevation of temperature. The increase was usually progressive, without much recession, and the maximum was reached just before death and sometimes afterward. The highest temperatures attained were  $109^{\circ}$  in one case,  $108^{\circ}$  in one,  $107^{\circ} +$  in eight,  $106^{\circ} +$  in ten, and  $105^{\circ} +$



in nine, or in twenty-eight cases it was above  $105^{\circ}$ . In eleven other cases it ranged from  $104^{\circ}+$  to  $103^{\circ}+$ . In three cases the post-mortem temperature was  $108.8^{\circ}$ ,  $109^{\circ}$ ,  $109.4^{\circ}$ . Sufficient data have been given to show that in probably no condition, except insolation, is the temperature so uniformly high as in cases of encephalic lesion.

Unconsciousness as an early symptom sometimes fails without apparent explanation in cases in which brain injury is undoubted. A variation of temperature, therefore, is the one invariable symptom, and if the patient has rallied from immediate shock, it is always an elevation. Perhaps, like the retardation of the pulse, depression of temperature may always be the primary change, but, if so, like the primary pulse change, it is too evanescent to be practically diagnostic. In many trivial head injuries elevation of temperature is absolutely the only symptom ever recognized. The symptoms should be rated in order of constancy, elevation of temperature, unconsciousness, and acceleration of pulse.

Since this elevation of temperature is a constant phenomenon, whatever the nature of the lesion or wherever situated, it would seem to be due to an affection of the cortex as a whole, and not to special lesions of localized heat centers. To this extent it might be comparable to experimental results in the attempt to discover cortical centers for organic functions. To what degree and in what manner the demonstrated heat centers are implicated in the general cortical change is not within the scope of this paper to discuss, nor within my province or competency to determine.

The primary effect of brain injuries may therefore still be attributed to an affection of the cortex in its totality, in accordance with von Bergmann's view, but manifested by two symptoms in place of one—an invariable variation in

temperature and a nearly invariable loss of consciousness. There is no reason to doubt that the medulla is next involved, and the effect of its stimulation and subsequent paralysis have been too thoroughly demonstrated to admit of question. The diagnostic value of the symptoms it affords, however, has not been apparent in these histories. I have not quoted the pulse records, because they have not been sufficiently characteristic to justify the necessary expenditure of time and labor.

The post-mortem observations disclose in every instance gross lesions in one or more regions of the brain or its membranes, which give a material basis for the symptoms which preceded death, whatever may have been the intervening processes which connected the structural change with its outward manifestations. It is for this reason that I would exclude the terms concussion and compression from systems of classification and descriptive histories of cases.

#### SYMPTOMATOLOGY.

The symptoms of injuries of the head, excluding those which are casual and without diagnostic significance, are fairly numerous. Fracture at the base has two symptoms peculiar to itself, and fracture of the vertex has also two; the others are common to both forms of fracture and to purely encephalic injuries. Those peculiar to fracture at the base are serous discharges from the ears or nose, and hæmorrhages from the ears, nose, or mouth, and into the orbital, subconjunctival, or cervical subcutaneous tissue. The characteristic symptom of fracture of the vertex, aside from a possible local serous discharge, lies in its perception by sight or touch. The symptoms of encephalic injuries, as a class, whether they occur independently or as complications of fracture, are superficial injuries; peculiarities of temperature, pulse, and respiration; unconsciousness; de-

lirium; irritability; paralysis; muscular rigidity; convulsions; anæsthesia and hyperæsthesia; pupillary changes; and, in a late stage, dementia. Other symptoms, as cephalalgia, vomiting, vertigo, incontinence of urine and feces, are frequent, but of lesser clinical value.

The hæmorrhages, serous discharges, and visual or tactile detection of fracture are pathognomonic. The hæmorrhages occurred in twenty cases and the serous discharge in one, and the necropsy in each confirmed the indication the symptom had afforded. In the fourteen cases in which they were absent, the line of fracture in each was found to be such as to preclude the escape of blood during life through any of the recognized channels. The direct evidence of fractured vertex was present in five cases, including three of gunshot wound.

There were simple contusions, large hæmatoma, or wounds, perceptible in fifty out of the fifty-eight cases. These superficial injuries were of great importance, not only by affording positive proof that violence had been suffered in cases where unconsciousness of the patient and absence of history rendered such confirmation essential, but by indicating the point at which it had been inflicted.

Sufficient has been said of variations of pulse and temperature and of unconsciousness, and little need be added in regard to peculiarities of respiration. In the majority of cases it was simply rapid or normal, and the chart records have not been transcribed for the same reason that they were omitted in case of the pulse. It was occasionally slow, in some instances not more than seven or eight in the minute, sometimes irregular or stertorous, sometimes of the Cheyne-Stokes variety, and in two or three instances dependent in character upon the presence of pulmonary œdema. As in case of the pulse symptoms, I have been struck by the habitual absence of distinctive respiratory in-

dications of medullary implication in serious cortical disturbances.

Delirium, or some form of mental impairment, is of rather frequent occurrence. It sometimes replaces unconsciousness as the earliest noticeable symptom, and sometimes appears as a much later manifestation. It may be violent and simulate alcoholic mania, or it may be mild and coexist with stupor. The most characteristic form of mental disorder which I have encountered in cases of head injury is that of nocturnal delirium, with more or less mental disturbance by day, and in time lapsing into permanent dementia as a termination, or sequel, of the traumatic lesion. It may follow at once upon recovery of consciousness, or it may succeed active delirium. At night the patient often requires mechanical restraint, while during the day he answers questions intelligently, is coherent in his speech, and may appear entirely rational. His memory, however, is defective, or wanting altogether, in regard to all the circumstances attending his injury. He has delusions and fails to recognize his surroundings. He is prone to drink his urine, and is often apathetic. His mind may finally become clear, his memory of lost events return, and his mental recovery be complete. In other cases his condition becomes one of dementia and some degree of mental impairment is permanent. Such a condition as I have described I presume is not novel to the alienist, but I note it as a special characteristic of injuries of the brain substance, not as a sequel, but as a symptomatic condition of recent lesion.

Another allied symptom is the sensitiveness to external irritations in cortical lesions. It seems to be not only a hyperanaesthesia of the cutaneous surfaces, but also a marked mental irritability. There is not only exaggerated muscular movement from slight irritations and disturbances, but the patient manifests great vexation and impa-

tience, though apparently unconscious. It is not usually followed by muscular spasm.

Convulsions, muscular rigidity, and muscular tremor may also be classed as irritative symptoms. The first and second occur in a considerable number of cases, a majority of which prove fatal, and upon necropsic examination disclose hæmorrhages and extensive lacerations and possibly general contusion. In the case of atrophy of the temporo-sphenoidal lobe, already described, convulsions were exceedingly severe; but they followed operation, and a single one occurred fifteen days after the original injury, so that it is by no means certain that there was any ætiological connection between the lesion and the symptom. It is fair to assume that they are always evidence of serious lesion, even when recovery follows. The few instances of muscular tremor were in men addicted to drink, but not intoxicated, and who died from the effects of extensive structural changes.

Paralysis and anæsthesia, general and local, are recognized indications of traumatic, not less than of idiopathic, affections of the encephalon. In the present series of cases they have occurred perhaps oftener than indicated in the histories, since in so many instances consciousness never returned. In this condition paralysis of the extremities and certain of the local paralyses—facial, ocular, or even glosso-pharyngeal—can be recognized; but many others, as well as sensory disturbances, remain hidden. The multiplicity of lesions, which is the rule rather than the exception, is confusing. In testing cutaneous sensibility the results are sufficiently contradictory and unsatisfactory even under more favorable conditions. Yet, despite all these difficulties, in two cases of lesion of the gyrus fornicatus the observations were productive of some result. In three cases of conjugate deviation, the necropsics afforded more



or less satisfaction according to the view taken of the location of the cerebral center. In a general way, however, while traumatisms may in some instances be of service in the solution of various unsettled questions in cerebral localization, such cases will probably continue to be exceptional. The fact that defined lacerations are so largely situated at the base of the brain, out of the region in which functional areas have been located, still further diminishes the chances that traumatism will aid much in perfecting cerebral topography. It is none the less important, in all cases of profound unconsciousness, to examine critically for such forms of paralysis as are undoubtedly recognizable as well as for those the discovery of which is likely to be more problematical.

Pupillary changes are valuable positive evidence of organic injuries, but are less important as negative signs. In a minority of fatal, as well as of recovering cases, I have found the pupils to be abnormal, either variable, unsymmetrical, dilated, or contracted. Unilateral dilatation is probably the most frequent deviation from the normal condition, and is likely to be associated with other and more decisive symptoms.

I shall not stop to consider casual or remote general symptoms, though, in connection with others more characteristic, they sometimes acquire a value which is not intrinsic. Vomiting and incontinence of urine and feces are among the most constant symptoms encountered in head injuries; but the one is not less frequent in peritonitis and pregnancy, and the other is quite as common in a great variety of functional and organic disorders of the brain which have no relation to traumatism. There can be no doubt, however, of the value of such indications when they occur under circumstances which render traumatism probable, either by the history or by the concurrence of more

directly suggestive symptoms. In the same connection occipital headache might be mentioned as so general in recovering cases of fracture of the base with epidural hamorrhage as to assume almost diagnostic importance.

I have not specifically noted in the various cases the symptoms which were not manifested, but with the exception of temperatures, when unmentioned, they may be regarded as absent.

The results of head injuries have been sufficiently indicated as recovery, death, and dementia.

#### DIAGNOSIS.

The diagnosis of injuries of the head as a class is always of interest, is usually practicable, and under some circumstances is one of the most important in the domain of surgery. Grievous error has entailed equal disgrace upon the surgeon and suffering upon the patient. These lesions are first to be distinguished from all other morbid conditions, especially from those involving loss of consciousness or delirium, and, secondly, they are to be discriminated from each other. It is unnecessary to enumerate or consider all those diseases which may simulate their symptoms. The one of primary and paramount importance, and which demands most earnest and careful attention, is the coma produced by alcohol. Its importance can not be overestimated, not only because it is the one with which the condition of traumatic coma is most likely to be confounded, but because error in diagnosis inflicts so much unnecessary suffering, additional danger, and possible disgrace upon the patient, while it places the most serious responsibility upon the surgeon. The number of instances in which injuries of the brain have been mistaken for alcoholic coma and the patient left to die in the cells of a police station, or committed to the alcoholic ward at Belle-

vue, or even sent from a police court to a term of imprisonment, is inexcusably great. A large proportion of such cases which came into my service at Bellevue, previous to the past year, were transferred from the alcoholic ward. It is a pleasure to acknowledge that within the year great progress has been made in the acquisition of knowledge among those who render first aid to the injured, even to the extent of realizing that an unconscious man with a scalp wound is not necessarily drunk, and that even a drunken man may be so seriously injured as to require hospital treatment. Unconsciousness and the existence of superficial injury of the head should in any case arrest attention and awaken suspicion of brain lesion. Coma ought not to be ascribed to alcohol, except by the strictest process of exclusion. Symptoms which are most likely to characterize different forms of head injury should be sought *seriatim*. It should be remembered, finally, that, even if the patient be intoxicated, this circumstance should strengthen rather than allay suspicion of traumatism. I believe the temperature affords the means of absolute diagnosis. I have shown, from the histories I have recorded and upon which this paper is founded, that variation of temperature in head injuries is invariable, and that in the exceptional instances in which it is depressed the severity of associated symptoms will take them out of the category of doubtful cases. In alcoholic coma the temperature is subnormal, and I have found this rule to be absolute. The one case which seemed to be exceptional was reported to me as having a temperature of 100°. Investigation proved it to be the result of *petit mal* from opium smoking in a young prostitute of the Chinese quarter who had not yet become accustomed to her mode of life. I have made some observations to determine the exact temperature in alcoholic coma. I have succeeded in obtaining upward of

twenty cases in which coma was more or less profound, and the temperature ranged from  $96^{\circ}$  to  $98^{\circ}$ , with a usually full and slow or normal pulse, and the depression of temperature was directly proportionate to the depth of coma. I had expected at the present time to have collected a larger number of cases, but I have found my opportunities unexpectedly limited. Whether it be the quality of whisky or the moral tone of the lower stratum of society which has improved I know not, but examples are no longer to be had for the asking. I believe, however, the absolutely uniform results in this number of cases makes it more than probable that a larger number in the future will corroborate the conclusion which has been reached.

In the diagnosis of apoplexy or non-traumatic cranial hæmorrhage, I have found that the observations of Bourneville coincide with those more recently made. They show that in the commencement of the attack the temperature is subnormal, that it then becomes normal, and remains at that point if the patient recovers, but if he dies it rises to a marked degree. In twenty-three cases taken from an accessible record, of which seven proved fatal, the temperature in two of the latter rose to  $102^{\circ}$  and  $104^{\circ}$ ; in all the others, fatalities included, the highest temperature was  $100^{\circ} +$ . This is in marked contrast to traumatic lesions in which the temperature continues to rise from the depression, if one existed, and remains elevated while the result remains in abeyance. A case which suggests the occasional difficulty in the diagnosis of idiopathic from traumatic lesion is that (Case CVIII) of the man previously quoted who was seized with an apoplectic effusion into his lateral ventricles and one occipital lobe, and fell from his cab, causing a cerebellar laceration. There is still another in this series very like it, in which a man after an apoplectic seizure fell backward, and, like the first, lacerated his cerebellum. In

both cases the previous history was known and it was possible to diagnosticate both lesions.

It is unnecessary to refer to uræmic coma, opium narcosis, hysteria, etc., as the diagnostic problems they present are elementary.

The active delirium which may occur in the period immediately succeeding the reception of a brain injury is sometimes very difficult to distinguish from that which results from alcoholic excess. The difficulty may be further increased by the fact that the subject is of known intemperate habits, and very likely intoxicated when first brought under observation. In those cases in which delirium is the first symptom noted, and probably replaces unconsciousness (as in Case I), the condition becomes very deceptive. In this instance we are not aided by the temperature, which is almost always elevated in alcoholic delirium, and elevation may be and often is very great. I have within a few days seen a case in which, with quite extensive superficial injury of the head, there was alcoholism to the verge of delirium, a high temperature, a previous history of epilepsy, and present epileptiform convulsions followed by facial paralysis. The diagnosis, which excluded brain injury and which proved to be correct, was made from observation of the course of the temperature for the first few hours. I am aware of no single diagnostic sign upon which dependence can be placed, and yet I have never seen a case in which it was not possible to make the distinction between the two forms of mental disturbance. There are few head injuries in which there are not at least one or two characteristic symptoms which can be detected if sufficient care be exercised in the examination of the case. It seems to me that there are differences even in the character of the delirium which may be recognized though not easily formulated.



The diagnosis from each other of the several injuries which may be inflicted upon the cranium and its contents is fraught with difficulties. The lesions are likely to be multiple and the symptoms to be equally referable to either one of their number; the symptoms of circumscribed lesion are often lost in those from one of a diffuse character, and similar results constantly ensue from totally different causes. A more exhaustive study of the diagnostic value of individual symptoms in their relation to each other, and to established structural changes, is therefore requisite than I have yet been able to undertake. There are, however, well-established facts, as well as strong diagnostic probabilities, which are likely to multiply and to make diagnosis possible in an increasing number of cases. Thus, it is well known that certain hæmorrhages positively indicate a definite fracture at the base. A trivial injury of the vertex and one or two general symptoms may suggest its whole extent and complications. Again, paralysis of an extremity in a recent head injury will positively determine some lesion of a definite portion of the parietal cortex on the opposite side. In the absence of depressed fracture, and with the knowledge that occurrence of laceration or limited contusion at this point is unusual, the ascription of the paralysis to hæmorrhage becomes justifiable. These conclusions are legitimate and founded upon positive knowledge and logical inference combined. There can be no doubt, I think, that greater diagnostic significance will attach to individual symptoms in the light of further pathological observation. As an example, the present series of necrologies seem to show that the peculiar mental conditions I have described are usually preceded by lesion of the brain tissue, and if it be of the membranes, that it is meningeal contusion with inflammation. I have insisted upon the importance of temperature in the recognition of head injuries as a class. I am not at

present prepared to raise the question of its diagnostic relation to individual lesions.

#### PROGNOSIS.

The prognosis may be first considered from the numerical results. The total number of cases is one hundred and twenty-four, of which forty-nine ended in recovery, or nearly forty per cent. The fractures at the base number seventy, of which twenty-one ended in recovery, or exactly thirty per cent.

The popular belief, and possibly the general professional impression, is that this fracture is a peculiarly fatal accident. I have already expressed the opinion that fracture at the base is devoid of danger except for its complications, but it is so often attended with grave lesions of the brain and meninges that it is not strange that by a species of metonymy it should come to stand for the traumatism as a whole.

It is difficult to estimate the comparative danger of the several lesions, from the fact that they are so generally multiple, and all together conspire to bring about the fatal result. It is also true that the severity rather than the form of lesion is to be made the basis of prognosis. It may be, therefore, of no great practical importance to attempt to infer from the necropsies the relative responsibility of individual lesions in causing death in each instance. So far as I may judge from comparisons of symptomatology with post-mortem appearances, when opportunity has been afforded, I believe death has directly resulted in fully fifty per cent. from laceration and attendant hæmorrhage. In the remainder it might be chargeable to epidural hæmorrhage, contusion, abscess, or arachnitis, though doubtless in every case some other lesion was contributory.

The prognosis made from initial symptoms must depend

upon their general severity and upon the extent to which the vital powers are implicated. It sometimes happens that the patient survives when the obvious extent of the lesion has made recovery seem practically hopeless. A fracture through both middle and one anterior fossa, and probably both, might well put an end to hope, and yet such a case (Case LXIX) did recover. I find that none of my patients have lived in whom the temperature has risen to  $105^{\circ}$ , but in more than one that degree was approximated. I am not at all certain it might not exceed  $105^{\circ}$  consistently with recovery. A very high temperature, or disturbance of respiration at an early period, or muscular rigidity, are always calculated to excite the gravest apprehension. The late prognosis presents no difficulties, but it ceases to be of professional interest.

#### TREATMENT.

I propose to confine whatever I may have to say in regard to treatment to questions of operation. I omit all reference to medication, as it involves matters of detail for which time is wanting. I premise only a brief mention of what may be properly designated adjuvants in general treatment. The necessity of shaving the head, which is conceded in cases with symptoms of marked severity, is equally existent in every case in which there seems to be a possibility of intracranial injury. It permits the discovery of diagnostic contusions which are so often disclosed only upon post-mortem examination. It relieves the brain, in some cases at least, of a superincumbent and thermogenetic weight, which is positively contraindicated and is a factor of appreciable influence. It facilitates the use of the ice cap, which in cases of high temperature and delirium is an appliance of the highest therapeutic value. I have found it so effective that I desire to emphasize its importance. I have sometimes been compelled to maintain its use for a

length of time, as whenever it was discontinued the temperature again increased and delirium returned. The resort to a simple form of mechanical restraint is often requisite for the mere purpose of retaining the patient in bed. It incidentally becomes at the same time a means of quieting nervous excitement and of husbanding physical strength.

Trephining may be regarded with less apprehension by the timid since the advent of aseptic methods. Its propriety may now be decided simply in view of its probable advantage, or its more probable futility. It may be counted quite as safe as the use of the exploring needle in suspected abscess, and safer than explorative laparotomy. I should not deem it necessary to insist upon this point were it not that I am so often surprised by denials of what I had taken to be conceded facts. If, as I am informed, the temperature rises to a high degree after craniectomy or trephining in children, it is so foreign to my experience in traumatism that I am constrained to attribute it to other causes than to simple perforation of the cranium. I have often found it, on the contrary, to be followed by a depression of temperature when no result had been attained beyond the mere removal of the button of bone. The incision of the dura, or the further exploration of the brain, might be differently regarded, for while trephining, done with due regard to time and method, could hardly inure to the serious disadvantage of the patient, uncalled-for and injudicious interference with the intracranial contents might be of positive disservice. This possibility is not a contraindication to going further after trephining, if its propriety becomes evident. In such case I have always found the temperature to rise as it does in injuries of the brain generally. In the small abscess which I incised through the angular gyrus it rose, in the sixteen hours which preceded death, from  $102.2^{\circ}$  to  $108^{\circ}$ . In the very large ab-

secess in the frontal lobe, upon which I operated only last month, the temperature rose from  $99.2^{\circ}$  in twenty-four hours to  $102.2^{\circ}$ , and recovery is even now complete. I should expect an elevation of temperature in any case, but I should not expect any serious results from incision of the dura or brain *per se*. So far as subsequent danger or inconvenience from hernia cerebri is concerned, I may repeat a statement previously made, that in the surgery of to-day it has ceased to be an intimidation to the surgeon.

I am quite of the same mind with those surgeons who believe that this operation should be done in every depressed fracture where elevation and thorough exploration can not be otherwise accomplished. I believe with them that the absence of general symptoms does not relieve the surgeon from the responsibility of operation. This view was held by my former preceptors, the late Dr. James R. Wood and Dr. J. W. S. Gouley, at a time when to hold such opinion was almost an opprobrium. It commended itself to my judgment then as it does now. It is doubtful if such an operation has been known to do harm when it has failed to do good. It is certain that harm has come in more than one instance where, because of the absence of general symptoms, it has been neglected. It is impossible to tell in a depression of the external table of moderate or perhaps insignificant extent what more extensive comminution of the internal table may not exist. It is this possibility of even the smallest bony spicula penetrating the brain and causing serious nervous disturbance in the indefinite future that demands thorough examination of every cranial fracture. It should be held obligatory on precisely the same grounds as the examination and cleansing of a wound in the external soft parts. The observance of such precaution is free from danger; its neglect may lead to either present or future serious complications.



If the depressed fracture is simple or its existence is in doubt, there should be no hesitancy in making sufficiently free incision to determine the exact cranial condition. It is of very common occurrence that a large hematoma exists in connection with diagnostic symptoms of intracranial injury, and that there is no other means than this of acquiring knowledge which may be of vital importance. If the result is nugatory, the incision, made under aseptic conditions, will be closed by primary union. It is certainly better to have made many fruitless incisions than to have allowed a single life to be jeopardized by an undiscovered fracture.

In case the fracture proves to be a simple fissure, a different rule of conduct will obtain. The probabilities will be against the existence of depression of the inner table, and after the fissure has been traced, with or without incision, as far as practicable, or till it has become narrowed to a line, the wound should be closed. If, however, the general symptoms should indicate complication, further exploration may become proper and necessary.

The indications for trephination are wanting at the present time in the great majority of cases which involve intracranial lesion. If the existence of epidural hemorrhage is evident and its location is accessible, the propriety of operation is unquestioned. If the existence of circumscribed lesion of the brain can be inferred from local paralyses, anaesthesia, or muscular rigidity, or from the initial symptom of convulsion, I think the propriety of operation may be assumed. In the greater number of cases, those in which only symptoms of diffuse lesion can be recognized, the use of the trephine is entirely empirical and without justification, unless undertaken for special reason. If in time lacerations at the base come to be diagnosed with reasonable certainty, it may then be proper

to inquire whether their exposure by the trephine or otherwise, disinfection, and drainage would be practicable and advantageous.

The accidental result of trephination, in at least two or three cases, suggests its employment on purely medico-legal grounds. I will instance the case (Case CVIII), already quoted as an example of mixed idiopathic and traumatic lesions, of a man who fell from his cab after an apoplectic effusion and secondarily lacerated his cerebellum. He was paralyzed, anæsthetic, and absolutely unconscious. He was trephined, and a large amount of serous fluid drained away from the surface of the brain. His temperature fell in six hours from  $103.4^{\circ}$  to  $98.6^{\circ}$ . He became conscious, could articulate, spoke rationally and intelligently, and gave his name and address. At the end of fourteen hours his temperature again rose and he died. The possibilities of such a case are not less practical than dramatic. The instances I have encountered of such transient returns to consciousness have been sufficiently prosaic and unimportant. The very next, perhaps, might disclose a criminal and avenge the crime. In any one of the many homicidal assaults in which the victim is found unconscious and the assailant has escaped unknown, I believe it to be legitimate to trephine for this direct purpose. Even temporary restoration of the mental faculties might suffice the ends of justice. The prospect of success is certainly not altogether chimerical, for I have cited a case in which just such a hypothetical result was absolutely attained.

The general principles of operative interference in cranial fractures and encephalic injury may be recapitulated and formulated as follows: Incision of the scalp, trephination, incision of the dura mater, and perforation of the brain, severally or together, should have resort without fear or hesitation when indicated. Incision of the scalp and

trephination are devoid of danger and are always justifiable for exploration, which in itself constitutes an indication. Incision of the dura mater and incision or perforation of the brain are more serious procedures, and should be made only when positively indicated by the general symptomatology.

I have sketched as rapidly and systematically as possible in this paper the conclusions to be derived from the series of histories and necrologies by which it is preceded. So far as they are confirmatory of previous observations, they will have the value which attaches to independent study. If in any particular they differ from accepted teaching, the inclusion of the historical data will make it easy either to verify their truth or to refute their error.

I beg to acknowledge my indebtedness to the courtesy of my colleagues, Dr. J. W. S. Gouley and Dr. F. S. Dennis, and also to the successive house surgeons at Bellevue and St. Vincent's Hospitals, for their intelligent co-operation in the work of observation.



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